S
333.954 Recommendations
N17rfw for fish &
1981 wildlife program
V.2 under the Pacific
Northwest Electric
Power Planning and
Conservation Act

RECOMMENDATIONS FOR FISH AND WILDLIFE PROGRAM

UNDER THE

PACIFIC NORTHWEST ELECTRIC POWER

PLANNING AND CONSERVATION ACT

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ANADROMOUS FISH CONTINUED

CHAPTER 3

OBJECTIVE III:

Natural Production

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OBJECTIVE III: NATURAL PRODUCTION

Natural production is that occurring in a natural state and without manmade changes. Prior to 1877, all salmon and steelhead originating from North America were the result of natural production. Exact figures in the historic levels of natural production are unavailable. However, estimates of historic and current production levels for various salmon producing watersheds of the Pacific Coast, as set forth in a Pacific Fishery Management Council report (1979), indicate that current levels are approximately 39 percent of historic.

The general decline of North American salmon and steelhead runs is a matter of record. The causes are manifold. Harvest levels have increased and massive alterations of salmonid producing habitat have occurred as a result of continued demand upon supporting land and water resources by an ever increasing human population. But no other influence upon salmonid survival can compare to the devastating impact of the hydropower system.

Initial exploitation of the salmon and steelhead resources generated the beginnings of artificial production techniques. In 1877, a hatchery operated by former Astoria, Oregon salmon cannery magnate R.D. Hume began to produce salmon fry on the Rogue River in southwestern Oregon. Since that time hatcheries have become commonplace and have generally been considered an acceptable method of augmenting natural production. It is now becoming apparent, however, that existing hatchery production, although a valuable tool for compensating unmitigabale losses is not sufficient to overcome the continuing impact of the hydro-system. Consider, for example, the situation on the Columbia River as set forth by Dawley, et al. (1981):

> "Natural runs of salmon, Oncorhynchus sp. in the Columbia River basin have decreased over the past forty years... This decline has necessitated increased salmon culture to assure adequate numbers of returning adults for the various fisheries.

> Hatcheries are now the primary source of salmon for the Columbia River, and in the late 1970's, annually produced about 100 million fall chinook salmon, O. tshawytscha, and 21 million spring and summer chinook salmon; 30 million coho salmon, O. kisutch, and 10 million steelhead, Salmo gairdneri. Even with hatchery production at this level, all management agencies agree that, in general, yields of Columbia River salmonids are deteriorating."

Hews (1947 as cited by Smith, 1979) estimated a yearly harvest of 18 million pounds of Columbia River salmon by indigenous peoples prior to white settlement of the Basin. These harvests were totally dependent on naturally produced fish. The average landing of commercially caught Columbia River salmon and steelhead during the period 1957-1979 was 7.3 million pounds (Oregon Department of Fish and Wildlife/Washington Department of Fisheries, 1981). This downward trend continues because hatchery production has not kept pace with the rate of decline in natural stocks.

Anadromous fish spawn in, and their progeny spend the first months (up to three years in some cases) of their lives rearing, in fresh water. They then move to a marine existence where they spend from two to four years before returning to fresh water to spawn and, generally, die. The adoption of anadromous behavior is believed to be a reaction to more abundant food supplies being available in the marine environment (Foerster, 1968).

The genus Oncorhynchus, the Pacific salmon, is generally believed to have emerged from a parent stock of the genus Salmo, the trout (including steelhead) and Atlantic salmon, early in the Pleistocene Epoch (Foerster, 1968). Further differentiation, eventually resulting in distinct species of Oncorhynchus, probably occurred as a result of long periodic glaciation and concomitant geograhic isolation of large population segments (Neave, 1958 as cited by Foerster, 1968).

The last major period of North American glaciation, the Wisconsin, extended from some 50,000 to perhaps 10,000 years ago. At its height, approximately 15,000 years ago, the Pacific Coast from southern Alaska to

northern Washington was buried under the Cordilleran Ice Sheet (McPhail and Lindsey, 1970). During this period, few if any streams existed between these areas, although the Yukon River Valley, located north of the sheet, was apparently ice free as were major drainage basins from the Columbia River south (Clemens, 1953 as cited by Foerster, 1968). Pacific salmon and steelhead undoubtedly spawned in those systems and, as the ice sheet receded, expanded their range into newly available coastal drainages. With only minor interruption, in comparison to the periods of glaciation, the anadromous salmonids have been utilizing the Pacific Coast of North America from south of the Sacramento River north since that time.

The success with which the salmon and steelhead have accomplished this occupation of habitat is plainly reflected by the diversity of species[1/], runs[2/], and stocks[3/] into which they have evolved. Each population segment has become, and continues to become, adapted to the habitat that it occupies. By becoming adapted the population survives. Adaptation is the mechanism of survival. The importance of adaptation and its relationship to survival cannot be overstated. Martin (1980) defined adaption as "the development of genetically based traits that increase fitness." He states:

> "The more adapted the population is to the habitat, the greater the average survival or yield to the fishery manager."

Fitness--the ability to survive and reproduce--results from a combination of genetic and environmental factors (Powell and Taylor, 1979). They state:

> "The relative selective value of an individual is therefore determined not only by its genotype but also by the environment in which it developed and the environment in which it is living."

The process whereby an organism or a population adapts to its environment is continuous and, therefore, requires an innate flexibility within the adapting organism(s). Without this, the organism or the population will likely perish due to its inability to adjust to the constantly changing

conditions surrounding it. The flexibility required--the ability to respond to change--lies within the genetic material that the organism, or population, is carrying. The greater the diversity of this material, the greater the probability that a response enabling the organism to survive will be available. A direct relationship exists between genetic diversity and the number of available responses. A greater array of responses increases the likelihood of survival through changing conditions. Genetic diversity, therefore, equates to survivability. The process through which the responses are applied to changing conditions in the environment is natural selection. Successful responses increase the likelihood of survival to time of reproduction. Unsuccessful responses reduce it. Those organisms reproducing pass on their "abilities;" those not reproducing do not.

In the strictest sense, a successful individual is one able to reproduce. When enough individuals reproduce to perpetuate the population, the population is successful. It remains, however, constantly reliant on its components. In order to ensure that sufficient individuals within the population will survive to reproduce that population, it is necessary to have within the population a diversity of individuals. This diversity will, in turn, increase the probability that individuals capable of adapting to changing conditions will be present and this will increase the probability that the population will be perpetuated. It is an exceedingly slow but constant process of change in response to change. Helle (1976) stated:

> "...animals with a high degree of adaptive genetic variability have a distinct advantage when exposed to the fluctuating natural environment.... Wild populations of salmon maintain adaptive genetic diversity through natural selection and their spawning behavior. Any form of artificial propagation that increases survival by reduction of natural mortality at any life history stage will change the genetic composition of the original stock."

A naturally propagating stock may appear to be operating inefficiently but it is this tendency toward slow, constant change that allows the population to progress. Those that survive do so because they are generally fit to survive. As stated by Moav, et al., (1978):

> "Natural environments, as a rule, offer fish relatively little protection, low feed inputs, a continuous strong pressure of selective harvesting and a strong intra- and intergroup competition. These features dictate evolution toward overall hardiness, competitiveness, efficient utilization of limited amounts of natural feed resources..."

There is a tendency in man to want to "improve" on apparently inefficient systems, but he often lacks the long-term perspective necessary to develop an accurate evaluation of how well a broad system is operating. Attempts to streamline the operation in some circumstances may create more problems than are solved. Biological or evolutionary success is measured over extremely long periods of time. Man's perspective, however, is generally limited to a few lifetimes. What may be viewed by man as inefficient in the short term may be highly workable when viewed at great length.

The purpose of a fish hatchery is, by and large, to replace lost habitat or to make this apparently inefficient system (natural production) more efficient by producing greater numbers of fish in less area and in a shorter period of time. So long as the limitations of this type of facility and the fish it produces are kept in mind, hatcheries will continue to be a valuable and necessary tool. When attempts are made to utilize a hatchery beyond its capabilities, problems will arise.

Under hatchery conditions there is a tendency to reduce the genetic diversity of the population through an "unnatural" selection by man. As a result of the relatively controlled conditions within the hatchery, a much greater survival rate from egg to fry is realized than occurs in a natural environment. Due to space restrictions within the facility and high egg

survival, only a relatively few adults are required to return to the hatchery, to supply sufficient reproductive products to utilize the incubation capacity. These few are selected by the hatchery personnel generally on the basis of a few "desirable" characteristics (e.g. size, time of return, overall appearance, etc.) and usually with little knowledge or consideration of their true worth in terms of perpetuating the population. A large, well-formed fish may be pleasing to the human eye, but these traits do not necessarily indicate inherent adaptability and survivability (AIFRB, 1975). Usually, any portion of the returning run not required for the hatchery production becomes surplus and is sold as carcasses. As a result, the genetic material of the surplus fish may be irretrievably lost to the population. As this annual process continues, a narrower and narrower genetic base will be utilized to maintain the population. Inbreeding will eventually occur and the population will tend to become monocultural, with all fish being genetically similar--carrying the genetic material of a relatively few parents. Should environmental conditions change to select against that material, the survivability of the population will be drastically, even dangerously, reduced. Calaprice (1969) addressed these dangers when he wrote:

> "Within a population, recombination, mutation, and immigration operate to increase genetic variance, while selection, emigration and chance happenings cause a reduction in genetic variability."

A reduction in the variability may be reflected by a reduction in fitness in the population undergoing natural selection and:

> "It is conceivable that the continuous stocking of hatchery fish ill-adapted to natural environments might result in a continuous lowering of the fitness and, if continued, the extinction of local populations."

The need for genetic diversity within a population of hatchery fish is not diminished as a result of the spawning, incubation, and partial rearing occurring under controlled conditions. Once the fish are released from the

hatchery, they must compete in an uncontrolled environment. Their survival, and ultimate contribution to the hatchery program, is dependent upon their ability to compete. Mere production and release of larger numbers of juveniles to offset the loss factor will not necessarily result in greater survival or larger returns to the hatchery (Gunsolus, 1978). The problem may, in fact, be compounded by this approach.

In order to preserve as much of the genetic diversity as possible, great care must be exercised in the use of hatchery fish to supplement wild runs where losses from downstream dams are too great to support productive fisheries and achieve desired wild escapements. Such hatchery supplementation of wild runs will unquestionably impact native fish populations.

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FOOTNOTES

1/ Species - The largest population unit in which an effective flow of genetic material can occur.

2/ Run - A group of stocks, within a species, having similar migration times.

3/ Stock - A breeding population of one species, generally inhabiting a specific stream.

Subobjective 3.1: Provide an optimal flow regime and habitat from Priest Rapids to the McNary Pool and from Hells Canyon Dam to Lower Granite Pool during anadromous fish spawning, incubation, emergence, and rearing periods.

Free-flowing portions of the Columbia and Snake Rivers available to anadromous fish have been severely restricted. Prior to hydroelectric development 1,200 miles of the mainstem Columbia River and 600 miles of the Snake River were available for salmon and steelhead spawning. Presently, only the Hanford Reach R.M. 345 to R.M. 399 on the Columbia and the Snake River from R.M. 140 to R.M. 247 are known to be suitable for natural production.

The fisheries habitat in these two river reaches are greatly affected by hydropower operations. In the Hanford Reach, average flows from upstream storage projects such as Grand Coulee determine daily, weekly, and even seasonal flows and therefore habitat suitability. On an hourly and daily basis, flows in the upper Hanford Reach are greatly affected by the operations at Priest Rapids Dam. Along the Hells Canyon stretch of the Snake River, flows on a daily, weekly, and seasonal basis are also altered by upstream storage such as Brownlee Reservoir and are affected on an hourly and daily basis by the regulation of Hells Canyon Dam.

Public Law 96-501 gives emphasis on the need to protect the habitat in these reaches of the Basin. This protection was included because of the serious extent to which power operations affect these areas, because of their great potential productivity, and because of the limited nature of their habitats. The emphasis in P.L. 96-501 appears in Section 2(6):

> "to protect, mitigate and enhance the fish and wildlife, including related spawning grounds and habitat, of the Columbia River and its tributaries, particularly anadromous fish which are of significant importance to the social and economic well-being of the Pacific Northwest and the

> Nation and which are dependent on suitable environmental conditions substantially obtainable from the management and operation of the Federal Columbia River Power System and other power generating facilities on the Columbia River and its tributaries.

This same emphasis is also provided in Sec. 4(h)(1)(A), (B), and 2(A).

For successful reproduction to occur in these river reaches, several habitat needs must be met. Suitable gravels unconfined by excessive levels of fine sediments is required for spawning substrate. Sufficient flows of proper temperature and chemical composition are necessary to provide depths and velocities over the substrate that are within the preferred ranges of the salmon and steelhead species. Following spawning and incubation river conditions must be suitable for rearing of fry and fingerlings.

Task 3.1.1: Provide a flow regime below Priest Rapids Dam to allow optimal utilization and provide full protection for fall chinook salmon and steelhead spawning, incubation, and rearing habitat in the Hanford Reach.

Introduction: The Hanford Reach of the Columbia River provides habitat or significant importance to upriver runs of fall chinook and steelhead. Fall chinook escapement to these spawning grounds, estimated by comparing counts of chinook from August through October over McNary, Priest Rapids, and Ice Harbor Dams and returns to hatchery facilities, has declined precipitously in the late 1970's following a building trend through the 1960's (Figure 1).

The value of this habitat has increased in importance as habitat for other fall chinook stocks and other species has declined. Hanford escapement presently accounts for about 80 percent of the upriver fall chinook run compared to 7 percent in 1962.

Estimation of steelhead escapement is difficult since fish spawn during the higher spring flows. Flows and turbidity make redd counts impossible. Based on counts at the three dams, assumed mortalities, and tributary populations, the Hanford area steelhead escapement is estimated at approximately 10,000 fish.

The great losses of habitat and fish in the upper Columbia Basin have increased the importance of fish production in the Hanford Reach. These fall chinook and steelhead help sustain the remaining fisheries, particularly those of the basin Indian tribes.

The potential impact of power operations at Priest Rapids Dam was first realized in April 1976. Discharge from the dam was held below 45,000 cfs for 32 hours during a Washington Public Power Supply System requested low-flow test. At Vernita Bar and downstream spawning areas, 1,417 chinook redds, a significant portion of the Hanford production, were dewatered resulting in a

Figure 1.

RETURNS OF FALL CHINOOK TO HANFORD REACH
Numbers of fish
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
McNary
Hanford Reach
Priest Rapids
Ice Harbor
Year 1962
64
66
68
70
72
74
76
78
80

complete loss of pre-emergent fry. Subsequent review of past flow records indicated that similar losses may have occurred but gone undocumented.

The following spring, power operations again resulted in major losses of eggs and fry. In mid-April, 443 redds were exposed at a flow of about 40,000 cfs. Redd sampling indicated mostly dead fry in the gravel despite attempts to flush the redds periodically with higher flows.

Priest Rapids Dam, Federal Energy Regulatory Commission Project 2114, controls the short-term flows in the Hanford Reach. The project license contains provisions for a minimum flow of 36,000 cfs. This flow was established, however, for the protection of downstream nuclear power facilities and does not account for the requirements of fishery habitat in the Hanford Reach.

Because of the insufficiency of the present project minimum flow to protect fishery reproduction and pursuant to Article 39 of the project's license, the fishery agencies and tribes have petitioned the Federal Energy Regulatory Commission to increase the minimum flow to 70,000 cfs. This flow should provide sufficient spawning habitat and adequate incubation and emergence conditions for anadromous fish.

Since the spring of 1976, additional data in the Hanford Reach has been collected to further define the extent and problem of redd exposure. These efforts have been concentrated at Vernita Bar since it is subjected to heavy spawning and the full impact of flow fluctuations.

Most recently, a Federal Energy Regulatory Commission settlement agreement between the mid-Columbia public utility districts and the fishery agencies and Indian tribes has stipulated four years of research to determine the impact of varying flows on the spawning and incubation success of fall chinook in the Hanford Reach. The studies were initiated in the fall of 1978 and will continue through the spring of 1983. It is planned that the data derived from these studies will be sufficient to determine the extent to which the present 36,000 cfs minimum flow should be increased.

Research results and observations to date indicate that: (1) fluctuating daily fall flows to drive chinook off the higher elevation spawning areas is unsuccessful in preventing significant spawning at the higher spawning areas presently exposed to dewatering; (2) pre-emergent fry (alevins) can not withstand dewatering; and (3) incubating eggs are more tolerant to dewatering than alevins but mortalities still occur (the extent of egg mortality due to varying dewatering regimes and environmental conditions is presently being further documented).

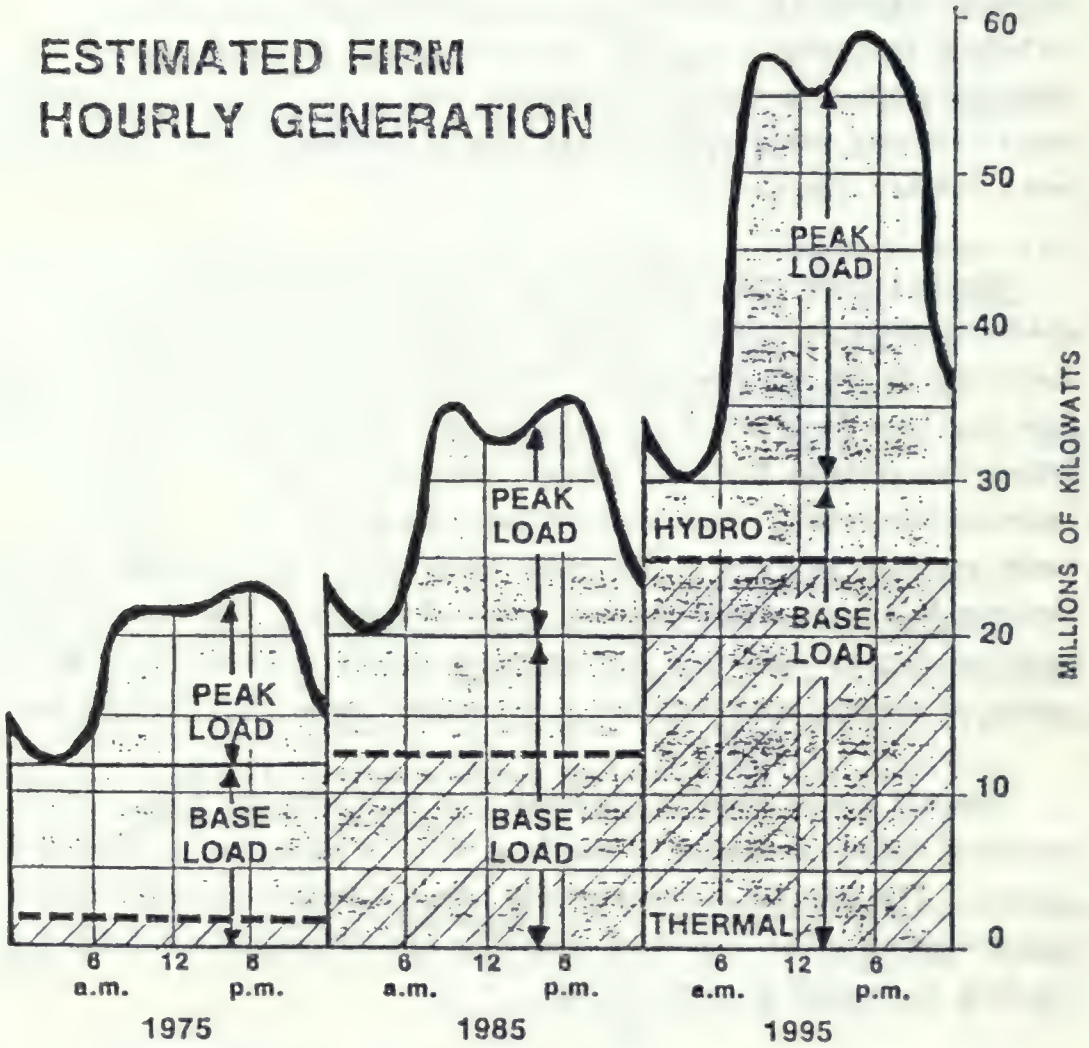
Studies since 1976 indicate that from 20 - 40 percent of the quantified spawning along four miles of habitat below Priest Rapids Dam occurs totally above the 36,000 cfs flow level. The percent of spawning above this minimum flow may be a function of the average flow during the spawning period. The higher the average flow, the greater percent of redds are formed above the minimum flow level. In five of the past six years (not including 1977, lowest water year) an average of 540 redds have been counted above the 36,000 cfs minimum flow level along this four miles of habitat. This spawning has occurred despite daily flow reductions to 36,000 cfs during the spawning period to harrass spawning fish and prevent spawning at the higher levels.

Present power peaking operations at Priest Rapids expose significant spawning habitat primarily in the first 10 - 12 miles downstream of the project. The peaking can potentially affect further significant habitat downstream on other important spawning bars if present minimum flow levels are held for longer periods of time.

Recent plans for development of the Pacific Northwest hydro-thermal system call for increased hydroelectric peaking as thermal plants provide the baseload energy needs (Figure 2). By 1985, it is expected that hydropeaking will have increased by about 50 percent over 1975 conditions and by 1995, the increase will be about 200 percent. Powerhouse expansions in the mid-Columbia, including Priest Rapids, would potentially provide much of this peak energy.

The impact of the increased peaking at Priest Rapids would be drastic magnification of the problems now occurring at Vernita Bar. Conditions for

Figure 2.



Thermal-Electric Generation in Northwest - 1975

Existing	5,952.5 MW
Under construction (last to be completed- 1982)	4,765.0 MW
Total	10,717.5 MW

the salmon and steelhead spawning, incubation, emergence, and rearing would worsen so that most of the Hanford spawning would be adversely affected. The projected magnitude of future fluctuations is about 17.4 feet (Figure 3). This level of peaking would impact most of the present and potential Hanford Reach anadromous fish reproduction.

Increased minimum flows for anadromous fish may limit the potential for future peaking operations and powerhouse expansion in the mid-Columbia.

Flow and power regulation studies using average monthly flows (Task 1.1.2) indicate that a minimum flow of 70,000 cfs could be maintained below Priest Rapids Dam.

Recommendation: That the Power Planning Council provide programmatic support to the remaining two years of Federal Energy Regulatory Commission ordered spawning and incubation studies below Priest Rapids Dam and include in its Fish and Wildlife Program increased minimum flows through the Hanford Reach, as determined in accordance with the Settlement Agreement. Increased peaking through powerhouse expansion should not be allowed pending the establishment of an increased minimum flow.

Figure 3.

U. S. ARMY ENGINEER DISTRICT, SEATTLE
Project Chief Joseph - Units Beyond 27
Subject Fluctuations in Priest Rapids-McNary Reach
By BOWERS/DYER Date May 19, 1975 Checked

LOCATION (River Mile)	1 Jan. 1995 1/			13 Jan. 1995 2/			1 Jul. 1995 3/			1 Aug. 1995 4/		
	Hourly	Daily	Weekly	Hourly	Daily	Weekly	Hourly	Daily	Weekly	Hourly	Daily	Weekly
396.55	7.9	17.7	18.8	8.2	18.3	18.5	6.3	15.8	16.8	4.1	12.5	12.5
387.70	5.9	15.7	16.2	6.1	15.6	16.3	4.9	14.6	14.7	3.2	11.7	11.7
383.22	4.9	12.6	13.7	5.8	12.6	13.8	4.6	12.4	12.5	3.2	9.9	9.9
376.46	2.6	10.0	11.6	2.7	10.5	11.8	3.0	10.0	10.3	2.0	7.9	7.9
369.96	2.6	10.5	12.3	2.7	10.8	12.4	3.1	10.1	10.3	2.1	8.3	8.3
365.51	2.3	11.8	13.0	2.4	12.3	13.1	2.6	10.2	10.5	1.7	8.5	8.5
361.04	2.0	11.4	12.8	2.0	11.8	12.8	2.6	10.8	11.2	1.8	8.8	8.8
347.32	1.2	6.6	6.9	1.2	6.7	7.0	1.4	5.8	5.8	1.0	4.6	4.6

Complete Study Names:
1 1 Jan. 1995 AW CT, 17 Dec. '74
2 13 Jan. 1995 AW CT, 26 Feb. '75
3 1 Jul. 1995 at EEC Study Case, 17 Feb. '76
4 1 Aug. 1995 at EEC Study Case, 17 Feb. '76

	River Mile
Priest Rapids Dam	397.0
Yakima River	335.2
Snake River	324.3

Task 3.1.2: Improve habitat conditions below Priest Rapids Dam to maximize utilization by fall chinook and steelhead

Under a 1978 Federal Energy Regulatory Commission settlement agreement concerning minimum flows below Priest Rapids Dam and the effects of these flows on salmon and steelhead reproduction, direction was provided to investigate means of improving spawning and incubation habitat as a potential means of mitigating the adverse effects of power peaking. Proposed by Grant County Public Utility District and included in the mandated study plan was the scarification of gravel substrate areas to improve their suitability for chinook spawning. The objective of the study was that by mechanically agitating the unused, cemented gravels, the finer sediments would be flushed out, thereby creating a new substrate more suitable for chinook spawning. Chinook might then be attracted to these new areas and away from that habitat adversely affected by power peaking.

These well-intentioned efforts did not result in any significant use by salmon. On three test plots scarified in 1979, only one redd was dug (Grant County Public Utility District, 1981). Preliminary results from additional habitat manipulation in 1980 indicates no redds were built by spawning salmon in the study areas. Continued scarification of river substrate to create spawning areas will not be further investigated in 1981.

At this time there does not appear to be any feasible and successful means of manipulating river substrate to create additional spawning areas for salmon and steelhead below Priest Rapids Dam. The fish still return to areas adversely impacted by power peaking operations.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program an increased minimum flow below Priest Rapids Dam determined by past studies and current Federal Energy Regulatory Commission ordered studies in accordance with the Settlement Agreement to protect, mitigate, and enhance salmon and steelhead spawning, incubation, and rearing

on the Columbia River. Habitat improvement must be accomplished through minimum flow increases rather than substrate scarification.

Task 3.1.3: Provide a flow regime below Hells Canyon Dam to allow optimal utilization of and provide full protection for fall chinook and steelhead spawning, incubation, and rearing habitat in the Snake River.

The free-flowing Snake River below Hells Canyon Dam provides valuable habitat for fall chinook salmon and summer steelhead. The river also provides a valuable sport fishery.

The need for increased minimum flows and reduced fluctuations below Hells Canyon Dam was a topic of 1979 hearings before the Federal Energy Regulatory Commission. In those hearings, petitioners, the fishery agencies, recommended the following flow schedule (testimony of Terry Holubetz).

Time Period	Instantaneous Minimum Flows	Rate of Fluctuation	Total Daily and weekly Fluctuation Range
0800 10/16 to 0800 12/1	12,000	1'/hour	No restrictions
0800 12/1 to 0800 3/1	10,000	1'/hour	No restrictions
0800 3/1 to 0800 5/1	10,000	1'/hour	2'
0800 5/1 to 0800 10/16	8,500*	1'/hour	2'

*8,500 cfs, or if inflow is less than 8,500, pass inflow but never to be below 5,000.

The recommended flow schedule was not meant to be applicable during extreme low-water years. Variances during these periods would be necessary.

An Oregon Department of Fish and Wildlife biologist familiar with the affected reach of river testified that the recommended fall flow of 12,000 cfs would restore fall chinook spawning area to about 90 percent of its historic level and approximately 70 percent of the optimum level (Testimony of Kenneth L. Witty). The flows would also provide for maximum levels of steelhead spawning habitat. Flows through the winter of 10,000 cfs or more would be sufficient to assure that spawn would remain covered during the incubation and emergence periods. Summer flows of 8,500 cfs or less would

be necessary to provide adequate juvenile rearing area. Fluctuation limitations were requested to prevent stranding of juvenile fish and allow suitable conditions for production of aquatic food supply. Justification for the flow recommendations was based on the results of observations and data collected and reported in "Anatomy of a River."

The February 14, 1980 Settlement Agreement following the hearing does not provide for improved Federal Energy Regulatory Commission license minimum flows beyond 1982. The Settlement Agreement provides that:

> "Petitioners agree that they will not for duration of the current Project 1971 license seek relief from the Federal Energy Regulatory Commission on any matter concerning Licensee's responsibility to compensate for salmon and steelhead losses under the Fish and Wildlife Coordination Act or the Federal Power Act nor seek changes in the operation of Project No. 1971 except that, on the basis of technological advances or substantial changes in condition, Petitioners may seek from the Federal Energy Regulatory Commission additional relief, if necessary, related exclusively to the enhancement of outmigration conditions for fall chinook smolts in the free-flowing stretch of the Snake River below Project No. 1971, after they are released by Licensee pursuant to this agreement. The parties agree that changes in operations within the restrictions of the existing license for Project No. 1971 shall not alone be considered a substantial change of condition.
>
> Further, in the event that storage space upstream of Project No. 1971 is hereafter acquired by the fishery agencies for the purpose of preserving or enhancing fish habitat or survival downstream of Project No. 1971, if the parties are unable to agree on the conditions under which water released from such space will be passed through Project No. 1971, Petitioners or Licensee may

petition the Federal Energy Regulatory Commission for an order setting forth the conditions under which water released from such storage space will be passed through Project No. 1971 by Licensee.

The Power Act provides a new opportunity to establish improved flows for fishery production below Hells Canyon Dam. Potential power losses to the Idaho Power Company and its customers from improved flows can be better evaluated and potentially offset by the Bonneville Power Administration under provisions of the Act's Sections 4(h)(6)(E) and 4(h)(8)(D). Establishing improved flows below Hells Canyon Dam under the direction of the Power Act should not violate the above provisions of the Settlement Agreement.

Improved flows for fisheries production may be attainable in part by use of existing unallocated storage in the Snake River Basin. Such storage exists at Cascade, Deadwood, and Lucky Peak reservoirs. Feasibility studies to develop new increments of storage on the Weiser River would also be appropriate to improve fishery flows and power production.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program investigation and establishment of improved flows for fisheries production below Hells Canyon Dam.

Subobjective 3.2: Improve anadromous fish spawning, incubation, rearing, and migration habitat directly affected by hydroelectric development, including provisions for optimal flows required for the utilization of that habitat, as mitigation.

Prior to the passage of the Power Act, compensation for fish losses by construction and operation of hydroelectric power facilities in the Columbia Basin was focused on the construction of hatcheries and improvement of fish passage conditions over the project structures. Hatcheries produced fish to replace those lst as a result of destruction of natural production areas, but insufficient attention has been given to opportunities available to improve remaining habitat to benefit both hatchery and natural-produced fish as a means of mitigating losses.

Considerable degradation of fish habitat loss occurred in many areas as a result of hydroelectric development. Much of the lost habitat values can be restored thereby increasing salmon and steelhead populations. Restoration or improvement measures which can be implemented include:

(1) adherence to optimal short and long-term flow regimes,
(2) installation of water temperature control facilities at existing projects,
(3) restoration or improvement of stream substrate and streamside conditions.

Suitable flows are necessary at various times for various reasons. Adult salmonids require sufficient flow depths to ascend the spawning streams throughout the travel route. Adequate flows are vitally necessary to cover redds following spawning, and to provide sufficient oxygen-bearing water to the resultant eggs and alevins. Abrupt, sudden changes in flows can wash out or strand juvenile fish and harm recreational harvest opportunities. Managed flows can also benefit the outmigration of smolts over project dams.

The improvement of water temperature conditions which have been altered by project construction, is possible through installation of temperature control facilities. Fluctuations from normal temperatures can vastly change fish behavior, as well as cause physical harm. Salmonids thrive only in a narrow range of suitable water temperatures. Varying regimes are required for spawning, incubation, and growth. Temperatures too low will inhibit the ascent of salmon seeking to spawn, thus preventing them from utilizing available upstream areas. High temperatures can accelerate disease losses and cause stress problems. These factors influence the lives of both adults and juveniles, and at various times and areas. There is ample opportunity for restoration of suitable temperature quality through proper project controls.

Fish production in natural habitat areas can be considerably improved as well as in stream habitat which has been altered by project construction. Suitable spawning gravel is a must for successful reproduction. Dams impact the substrate conditions by slowing upstream flows thus causing silt deposition. The transport of new gravel to lower areas is also impeded. Abrupt flow fluctuations can wash away soils from formerly stable banks. Resulting heavily silted gravel is useless for salmonid spawning. Some progress has been made in restoring such gravel areas by cleaning with mechanical methods. The creation of suitable spawning substrate, through adding aggregate material to now unusable areas, has shown some promise.

Improvement of streamside vegetation will result in multiple benefits through halting bank erosion, producing shade and cover, and allowing insect populations to accumulate. Reduction of bank erosion through increased vegetative cover creates a more stable stream system by causing the stream banks to retain and release moisture throughout the year. Gravel siltation is also much reduced. Increased shade along the stream reduces the potential of harmful high water temperatures during summer months. Minor alternations of stream channel configuration, gradients, etc., can render marginal habitat more suitable for use by anadromous salmonids.

Task 3.2.1: Willamette River and Tributaries

The Corps of Engineers has constructed a 13-dam multipurpose water storage complex in the Willamette Basin. The major projects in the system include Detroit, Green Peter, Lookout Point, and Cougar reservoirs. The purposes, priorities, and operating plans for the 13 projects were specified by Congress in House Document 531, Eight-First Congress, Second Session.

The reservoir complex had substantial impact on anadromous fish habitat by blocking access to vast spawning and rearing areas and by influencing flows and other habitat parameters downstream from the projects. In recognition of these impacts, Congress included provisions for passage, hatchery compensation, and minimum flows (see Task 1.2.1) in the authorization of the projects.

Over the past several years, the Corps has coordinated most pertinent reservoir operations with state and federal fishery agencies. Often the advice of the agencies has been accepted; however, there have been occasions when minimum flows have been violated against fishery agency advice.

H.D. 531 recognizes the need to maintain anadromous fish runs in the Willamette River system. Based on experience and several research studies in the Willamette, fishery agencies prepared the attached flow guidelines (Oregon Department of Fish and Wildlife, Unpub. m.s., 1979) which to base recommendations on reservoir operations to the Corps of Engineers. These guidelines were developed to provide suitable conditions for the maintenance

of anadromous runs and to provide suitable conditions for the sport harvest of these fish.

Recommendations: That the Power Planning Council include in its Fish and Wildlife Program direction to the Corps of Engineers to incorporate Willamette Basin fishery flow guidelines into the annual operation of the Willamette projects to provide habitat conditions suitable for the maintenance of anadromous fish runs.

FLOW REGULATION GUIDELINES FOR FISH

The following guidelines are to provide a basis of reference for making decisions. They will not replace recommendations from field people. Each situation will be judged on its own merits. However, these guidelines should provide a better basis to look at each situation and decide what the effects will be on fish from a reservoir operation change. These guidelines should be expanded and updated as better information and operating experience is gained. Flows stated in this section will not supersede those granted in House Document #531, 81st Congress, 2nd Session.

1. Minimum flows in the lower Willamette from Oregon City to the mouth needed to provide upstream fish passage.

   Six thousand cfs at Willamette Falls will provide at least five parts per million dissolved oxygen, and allow upstream migration of salmon and steelhead. Water temperatures must be suitable (above 52°) at any flow for chinook. Desirable flow to provide higher dissolved oxygen and adequate temperatures in warmer weather is 9,000 cfs.

   To hold reservoirs high enough to have adequate downstream flows and temperatures during spring and fall chinook spawning and incubation time, and to provide 6,000 cfs of natural and stored flow in the lower Willamette during the low flow period, a total basin storage of 1,824,000 acre feet is needed at CE's reservoirs.

2. Flows needed for good upstream passage of salmon and steelhead.

Location	Flow cfs	Time Period	Species	Regulation Point
M F Willamette Riv	900	Apr 15-Jun 30	S Chinook	Dexter Dam
below Dexter Res	700	Mar 1-Apr 15	Steelhead	
S Santiam Riv	900	Apr 15-Jun 30	S Chinook	Waterloo
below Foster Res	900	Sep 1-Sep 30	F Chinook	
	700	Mar 1-Apr 15	Steelhead	
		Jun 30-Oct 1		
N Santiam Riv	900	Apr 15-Jun 30	S Chinook	Big Cliff Dam
below Big Cliff Res	900	Sep 1-Sep 30	F Chinook	
	700	Mar 1-Apr 15	Steelhead	
M Santiam Riv 1/	50	Mar 1-Jun 30	S Chinook	Green Peter
below Green Peter			Steelhead	
Fall Cr 2/	170	Apr 15-Jun 30	S Chinook	Fall Cr Dam
below Fall Cr Dam	75	Mar 1-Apr 15	Steelhead	
Coast F Willamette	200	Oct 15-Dec 1	F Chinook	Just below
mouth to Row Riv	175	Jan 1-May 15	Steelhead	Row Riv
Row Riv	175	Oct 15-Dec 1	F Chinook	Dorena Dam
below Dorena Dam	150	Jan 1-May 15	Steelhead	

1/ Flow should be reduced to 50 cfs for part of each afternoon period during fish passage season to bring fish into the fish ladder.

2/ Experience at Fall Creek in 1977 and 1978 showed that 150 cfs is sufficient to provide adult transport, this flow should not be frequently interupted with lower flows. Considerable straying of marked fish occurred when a weekly flow schedule of three days at 150 cfs and four days at 50 cfs was followed.

These minimum flows are based on observations of fish passage during lower flows, measurements of river cross-sections, comparisons with similar size streams with similar flow regimes where good imformation is available, and an Oregon Game Commission basin report.

3. Minimum spawning flows below each reservoir.

Location	Flow cfs	Time Period	Species	Regulation Point
M F Willamette Riv below Dexter	1200	Sep 10-Oct 10 Mar 1-Jun 1	S Chinook Steelhead	Dexter Dam
S Santiam Riv below Foster	1000	Sep 10-Oct 10 Mar 1-Jun 1	S Chinook F Chinook Steelhead	Waterloo
N Santiam Riv below Big Cliff	1000	Sep 10-Oct 10 Mar 1-Jun 1	S Chinook F Chinook Steelhead	Big Cliff Dam
Fall Cr below Fall Cr	150	Sep 10-Oct 10 Mar 1-Jun 1	S Chinook Steelhead	Fall Cr Dam
Row Riv below Dorena Dam	200	Oct 15-Dec 10 Mar 1-Jun 1	F Chinook Steelhead	Dorena Dam
Coast F Willamette Riv mouth to Row Riv	250	Oct 15-Dec 10 Mar 1-Jun 1	F Chinook Steelhead	Just below Row Riv
S F McKenzie	400	Sep 10-Oct 10	S Chinook	Cougar Dam
McKenzie Riv Blue Riv to mouth	2500	Sep 10-Oct 10	S Chinook	Vida
Willamette Riv McKenzie to Corvallis	6500	Sep 10-Oct 10	F Chinook	Harrisburg

These Flows are based on biologists' observations during spawning time, cross-section measurements, comparison with similar streams where better information is available, and an Oregon Game Commission basin report.

4. Minimum incubation flows below each reservoir.

Location	Flow	Time Period	Species	Regulation Point
M F Willamette Riv below Dexter	one foot lower than flow level at spawning time	Oct 1-Mar 15 Apr 1-Jun 15	S Chinook Steelhead	Jasper
S Santiam Riv below Foster Dam	800 cfs one foot lower than flow level at peak spawning	Oct 1-Mar 15 Apr 1-Jul 1	S Chinook Steelhead	Waterloo
N Santiam below Big Cliff Dam	1000 cfs one foot lower than flow level at peak spawning	Oct 1-Mar 15 Apr 1-Jul 1	S Chinook Steelhead	Big Cliff Mehama
Fall Cr below Fall Cr Dam	150 cfs 75 cfs	Oct 1-Mar 15 Arp 1-Jul 1	S Chinook Steelhead	Fall Cr Dam
Row Riv below Dorena Dam	150 cfs	Nov 15-Apr 1 Apr 1-Jun 15	F Chinook Steelhead	Dorena Dam
Coast F Willamette Riv mouth to Row Riv	250 cfs	Nov 15-Apr 1 Apr 1-Jun 15	F Chinook Steelhead	Goshen
S F McKenzie Riv below Cougar	400 cfs	Oct 1-Mar 15	S Chinook	Cougar Dam
McKenzie Riv Blur Riv to mouth	2000 cfs	Oct 1-Mar 15	S Chinook	Vida
Willamette Riv	one foot lower than flow level at peak spawning	Oct 1-Mar 15	F Chinook	Harrisburg

These flow recommendations are based on a water stage one foot lower than usual high flow during peak spawning, and an Oregon Game Commission basin report.

5. Minimum Reservoir storage to provide adequate temperature range during spawning time in the fall.

Reservoir	Minimum Reservoir Storage on June 30 AF	Minimum Reservoir Storage on Oct 10 AF
Lookout Point[1/]	370,000	270,000
Green Peter	305,000	195,000
Detroit	370,000	255,000
Fall Creek	105,000	60,000
Cougar	160,000	90,000

1/ Based on the assumption that Hills Creek will be operated to provide flows of 1000 to 1500 cfs from August 1 until mid-September or later.

These reservoir levels were calculated from expected reservoir temperature profiles and normal outflows for the conservation season.

6. Maximum flow during spawning to keep redds in water during incubation.

Location	Flow cfs	Time Period	Species	Regulation Point
N F Willamette Riv 1/ below Dexter Dam				
S Santiam Riv below Foster Res	2000	Sep 10-Oct 10	F Chinook	Waterloo
N Santiam Riv below Big Cliff	2400	Sep 10-Oct 10	S Chinook F Chinook	Big Cliff Dam
Fall Cr 1/ below Fall Cr Dam				
Row Riv below Dorena Dam	690	Oct 15-Dec 10	F Chinook	Dorena Dam
Coast F Willamette Riv mouth to Row Riv	850	Oct 15-Dec 10	F Chinook	Goshen
S F McKenzie Riv below Cougar Dam	1100	Sep 10-Oct 10	S Chinook	Cougar Dam
McKenzie Riv from Blue Riv to mouth	3700	Sep 10-Oct 10	S Chinook	Vida
Willamette Riv McKenzie to Corvallis	7500	Sep 10-Oct 10	F Chinook	Harrisburg

1/ Because of large fluctuations of stream levels under normal operations of the reservoirs it may not be practical to recommend maximum spawning flows below these reservoirs.

These flows maintain river level one foot higher than low flow levels which may occur during the time the eggs and fry are in the gravel.

7. Maximum allowable flow fluctuations (except during flood control regulation for N Santiam, S Santiam, and M F Willamette).

	Outflow, cfs		
	750-1500	1500-3000	3000-10,000
Maximum hourly change	+200, -100	+300, -200	+2000, -1000
Maximum 24-hour change	+350, -300	+700, -600	+6000, -4000

These limits are based on information from cross-sectional measurements made at several flows on the North Santiam River.

8. Minimum flows for salmonid rearing.

Location	Flow cfs	Time Period	Regulation Point
M F Willamette Riv below Dexter Dam	1600 800	Jun 1-Oct 30 Nov 1-Jun 1	Dexter Dam
M F Willamette Riv from Hills Cr Dam to Lookout Point Reservoir	285	Throughout year	Hills Cr Dam
S Santiam Riv below Dexter Dam	800 600	Jun 1-Oct 30 Nov 1-May 30	Waterloo
N Santiam below Big Cliff Dam	1000 800	Jun 1-Oct 30 Nov 1-May 30	Big Cliff Dam
Fall Cr below Fall Cr Res	150 50	Jun 1-Oct 30 Nov 1-May 30	Fall Cr Dam
Row River below Dorena Dam	300 100	Jun 15-Nov Nov 1-Jun 15	Dorena Dam
Coast F Willamette Riv mouth to Row Riv	350 200	Jun 15-Oct 30 Nov 1-Jun 15	Goshen
S F McKenzie Riv below Cougar Dam	250	Throughout year	Cougar Dam

9. Quantity and duration of flows needed to initiate downstream migration.

Minimum releases below all projects provide water to transport smolts downstream. These minimum releases are shown on the table of pertinent reservoir data. If smolts of each species are released at proper time and size, they should begin migrating downstream. Any increase in flows would facilitate this movement. An increase of 20% for 10 days would have significant effect in causing smolts to migrate downstream. Any additional flow above the 20% previously mentioned would increase the speed of migration. Conversely any flow increase that increases the temperature up to 55°F particularly in the North Santiam could be of benefit (spring chinook smolts released from South Santiam Hatchery under optimal conditions have migrated past Wallamette Falls in 25 days).

10. Flows needed over Willamette Falls during periods of migration to provide for smolt passage and best conditions for upstream passage of spring chinook.

Under the present hydroelectric operating regime at Willamette Falls, any flow below 10,000 cfs at Salem will put most of the smolts through the hydroelectric plants or over the falls with low flows causing some injury on the rocks. If Sullivan Plant is screened, a flow of 15,000 cfs at Salem would probably be adequate for smolt passage; 20,000 cfs would be better. These flows are needed from November 1 to December 1 for juvenile spring chinook passage in the fall, and from March 15 to June 25 for smolt passage in the spring for all species. March 20 to May 31 is a critical period for spring smolt migration of all species except fall chinook. The critical period for fall chinook is from May 20 to June 20.

Spring chinook upstream passage at Willamette Falls is geared to temperature and flow. The temperature must reach 52°F to 55°F before substantial passage will take place regardless of flow. From comparing counts at the falls with flows at Salem, 12,000 cfs and below is optimal for passage of spring chinook using the new ladder. This can be increased to 15,000 if flash boards are installed at the falls. Flows above this appear to retard migration even though water temperture is adequate. Flows of 20,000 appear to cause passage problems. Flows above 20,000 and water temperature below 52°F can cause complete blockage and avoidance of the new ladder. Peak passage will occur at Willamette Falls between May 1 and 10 if flows and temperatures are adequate. Peak passage later than May 10 indicates some type of blockage has occurred. In most years, adults delayed at Willamette Falls have difficulty passing upstream to the projects and are in poor condition when they arrive at the hatchery holding facilities. Adults in poor condition suffer substantial delayed mortalities.

Controlling the river to provide less than the 15,000 cfs during the peak of spring chinook upstream migration is desirable, however, in many years this is not possible.

PERTINENT SERVOIR DATA

WILLAMETTE RIVER BASIN RESERVOIRS

SEPTEMBER 1972

RESERVOIR	Normal Max Release	RELEASE IN C.F.S. DURING HIGH FLOW PERIODS: Minimum Release	Max Rate of Increase: Normal Per Hr.	Max Rate of Increase: Limit Max Per Hr.	DURING LOW FLOW PERIOD: Minimum Release	Max Rate of Increase: Normal Per Hr.	Max Rate of Increase: Limit Max Per Hr.	Limit of Reduction in Outflow Per Half Hr.	FIRM POWER RELEASE	OUTLET WORKS	SPILLWAY CREST ELEVATION (FT., M.S.L.)	NO. OF UNITS	RATING PER UNIT
FALL CREEK	4500	50	50 — 1000 = 300 1000 — 4000 = 500	800	May-June 150 (FISH) Jul-Apr 30	200	200	4000	—	2 Outlets 2 Spwy	791.6	—	—
COTTAGE GROVE	3000	50	350	500	75 Feb-June 50 July-Oct	100	100	3000	—	3 Outlets Open Spwy	791.0	—	—
DORENA	5000	100	100 — 2000 = 500 2000 — 5000 = 750	1000	190 Feb-June 100 July-Oct	200	200	5000	—	5 Outlets Open Spwy	835.0	—	—
FERN RIDGE	4000	50	750	1000	50 Feb-June 30 June-Nov	200	200	4000	—	4 Outlets 1 Sluice 6 Spwy	358.5	—	—
BLUE RIVER	3700	50	50 — 100 = 50 PER HALF HR. 100 — 500 = 100 " " " 500 — 1000 = 200 " " " 1000 — 2000 = 400 " " " 2000 — 3700 = 600 " " "		50	50 — 100 = 50 PER HALF HR. 100 — 500 = 100 " " " 500 — 1000 = 200 " " " 1000 — 2000 = 400 " " " 2000 — 3700 = 600 " " "		30% (Below 200 CFS 30% per 15 Min.)	—	2 Outlets 2 Spwy	1321.0	—	—
HILLS CREEK	8000	100	100 — 1000 = 300 1000 — 5000 = 500 500 — 8000 = 800	1200	100	300	300	4000	800	2 Outlets 3 Spwy	1495.5	2	15 MW 800 CFS
LOOKOUT POINT	15,000	500	500 — 1000 = 500 1000 — 4000 = 1000 4000—15000 = 1500	2500	1200 Feb-June 1000 July-Nov	500—4000 = 300 4000—15000 = 500	500	30%	2800	4 Outlets 5 Spwy	887.5	3	40 MW 2500 CFS
DEXTER										7 Spwy	660.0	1	15 MW 4000 CFS
COUGAR	6500	100	100 — 500 = 250 500 — 6500 = 500	750	300 Feb-June 200 July-Nov	200	200	3000	750	2 Outlets 2 Spwy	1656.75	2	12.5 MW 450 CFS
GREEN PETER	11,000	50	—	—	50	—	—	—	2100	2 Outlets 2 Spwy	968.7	2	40 MW 2000 CFS
FOSTER	18,000	Inflow up to 10,000	500 — 1000 = 500 1000 — 3000 = 1000 3000—18000 = 1500	2500	800 FEB-APR 750 MAY 600 JUNE 400 JULY-NOV	300	300	30%	2500	6 Spwy	596.79	2	10 MW 1600 CFS
DETROIT	17,000	100	100 — 1000 = 500 1000 — 3000 = 1000 3000—17000 = 1500	2000	1000 Feb-June 750 July-Nov	750 — 3000 = 200 3000—10000 = 500	500	30%	2000	4 Outlets 6 Spwy	1541.0	2	50 MW 2300 CFS
BIG CLIFF										3 Spwy	1161.5	1	18 MW 3000 CFS

11. Flows needed in the lower river to provide good downstream passage and temperature conditions for smolt.

Flows adequate for smolt passage over the falls, (15,000-20,000 cfs) will suffice below the falls since the Clackamas enters just below. Water temperatures of 60°F or above greatly increase the opportunity for smolts to die of disease. Temperatures of 62°F and above are critical for Skamania summer steelhead and native Willamette winter steelhead smolts. Smolts entering the Columbia in the spring usually encounter cooler water. No temperature thresholds have been determined for salmon encountering disease problems in the Willamette stock show substantial resistance to major bacterial diseases.

12. Minimum flows for drift boats fishing in the tributaries below dams.

River	Flow-cfs	Regulation Point
M F Willamette Riv below Dexter Dam	800	Dexter Dam
S Santiam Riv below Foster Dam	800	Waterloo
N Santiam Riv below Big Cliff Dam	1000 experienced 1500-2000 novice	Big Cliff Dam

13. Storage needed in the basin.

At 80% or below of basin storage in CE reservoirs, most flexibility is lost for reservoir regulation to benefit fish. Lookout Point, Green Peter, Detroit, Fall Creek, and Cougar reservoirs should be filled to the point where they could provide adequate spawning temperatures plus Hills Creek and Fern Ridge at the same percentage full as the ones mentioned above. The rest of the reservoirs should be filled to maximum conservation pool.

14. Pool elevations at which the trout fishery begins to suffer.

Reservoir	Level at which some boat ramps become inoperative. Pool Elevation, Ft.	Storage, A F
Hills Cr	1506	266,000
Lookout Point	901	306,000
Dorena	826	62,600
Cottage Grove	779	20,500
Cougar	1636	147,900
Blue River	1331	66,000
Green Peter	991	343,000
Foster	623	43,000
Detroit	1545	375,200
Fern Ridge	367	53,500

The pool level at which the trout fishery begins to suffer is the level which some boat ramps become inoperative, and access is restricted.

15. Flushing sequence at Fall Creek Reservoir to allow spring chinook smolt emigration and to produce the least effect on flow and turbidity.

Beginning about November 5, or as early as October 15 if freshet conditions occur, reservoir level should be reduced from minimum pool to stream bed level as quickly as possible. Evacuation below 3000 acre feet should not be accomplished until inflows are 500 cfs or above to allow an adequate refilling rate. The reservoir should be held at stream bed level for one hour and then filled to minimum pool as soon as possible.

Task 3.2.2: Deschutes River - Pelton, Round Butte Dams

Introduction: The Deschutes River supports popular sport fisheries as well as a unique Indian dipnet fishery at Sherar's Falls for wild fall chinook and summer steelhead. Most of these chinook and steelhead spawn in the lower 160 km of the Deschutes below the Pelton-Round Butte hydroelectric complex. A decline in quality and quantity of spawning gravels as a direct result of controlled flow and restricted gravel movement by the dams over the last 20 years are suspected to be partially responsible for recent declines in wild steelhead and fall chinook. Because of the degraded gravels in the lower river, spawning distribution of fall chinook has shifted from 12 percent in the upper river in the mid-1960's to about 50 percent in the last few years with superimposition of redds now common in the upper spawning areas.

Needed Research: Research is required to determine the status of spawning gravels since the dams were completed on the Deschutes River. Once problems have been identified, solutions that could increase the amount or suitability of gravels to pre-dam levels could be implemented. The overall goal of this work is to increase the production of wild fall chinook and summer steelhead on the Deschutes system.

The proposed study is possible because of a detailed, comprehensive study of the distribution, quantity, utilization and suitability of spawning gravels in the Deschutes River conducted by Aney et al. (1967). Their data were collected shortly after Round Butte Dam was completed on the Deschutes and would form the basis for our proposed evaluation.

Data are not currently available to determine whether spawning gravels for wild chinook and steelhead have changed since the dam complex was completed. However, an excellent data base exists from which this determination can be made. We recommend that a study be implemented to determine if the suitability and/or amount of gravels in the mainstream have declined since the mid-1960 study. The proposed study would identify areas that have changed, the nature of the problems, and recommended solutions at specific sites.

Results: If the research is conducted and the recommendations implemented, recruitment to rearing areas will increase because of more available spawning area and higher survival from egg deposition to emergence. Subsequently, adult chinook and steelhead returning to Columbia and Deschutes rivers fisheries to spawn will increase.

Scope: The specific tasks to accomplish the objectives are:

1. Determine if distribution of spawning gravels has changed since the mid-1960's study.

2. Determine if amounts of gravel on four study sections (1960's study) has changed.

3. Determine if quality (i.e. percent fines, compaction, permeability) has changed.

4. Determine changes in utilization by chinook and steelhead.

5. Recommend conduct prototype corrective actions for areas where detrimental impacts have occurred and estimate potential for increasing runs of fall chinook and steelhead.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program research on the Deschutes River to determine the extent of spawning gravel degradation and means to improve its suitability.

Task 3.2.3: Cowlitz River

Extensive natural production of anadromous fish exists downstream of Mayfield Dam on the Cowlitz River. The majority of this production is fall chinook salmon; however, some coho, spring chinook, chum, steelhead, and sea-run cutthroat trout are also present. Studies regarding the freshwater life history of fall chinook on the Cowlitz River (Bauersfeld, 1978) have demonstrated the need to have operational constraints and minimum flow requirements for Mayfield Dam. Bauersfeld's study indicated that serious stranding of chinook fry occurs when flows are reduced below a flow of 5,000 cfs as measured at Mayfield Dam. Tacoma City Light has been apprised of this situation and has attempted to keep flow fluctuations to a minimum when operating below the 5,000 threshold flow.

In addition, field studies have been completed that describe spawning incubation and rearing flow needs for fall chinook and steelhead. McKinley (1956) developed minimum and maximum optimal spawning flow levels for fall chinook in the lower Cowlitz River. Field observations have also provided data on minimum flow needs for incubating salmon and steelhead embryos.

Based on the above information, a formal agreement has been developed and implemented (1977) that provides protection for the anadromous fisheries resource downstream of Mayfield Dam. This agreement, between the Washington Departments of Fisheries and Game and Tacoma City Light, was the first of its kind in the State of Washington. The agreement, in the form of a flow regulation schedule (attachment), provides protection to fish during their spawning, incubation and rearing periods. The Federal Energy Regulatory Commission has been asked to include this agreement as a part of City of Tacoma's project license; however, as of this writing, this has not been done.

Additional work has been conducted to ensure that water quality remains high in the lower Cowlitz River. Nitrogen tests have been conducted that show that nitrogen supersaturation is not a problem during normal spill situations. Water temperatures are kept within an acceptable range for

salmonids by drawing water below the surface of Mayfield Lake during the summer months when surface temperatures are high.

Although the production potential of the upper Cowlitz River has been severely limited (see Task 1.2.3) there is the possibility that a significant portion of this basin could be rehabilitated if an effective downstream migrant fish facility is developed. That possibility now exists because Lewis County Public Utility District is proposing a low-head dam, to be located immediately above the Mossyrock pool. This low-head project with a relatively small reservoir could provide the opportunity to develop an effective migrant collection device and allow use of the upper watershed again. Accordingly, the fisheries agencies have requested Lewis County Public Utility District to incorporate into the design plans for the Cowlitz Falls Dam, the capability to retrofit the project, at some later date, with a louver or other screening device should it become feasible. The public utility district has considered this request and has indicated they are willing to incorporate this into their design plans.

Recommendations: That the Power Planning Council adopt in its Fish and Wildlife Program the "Flow Regulation Schedule for Mayfield Power Plant" to ensure productive fisheries in the Cowlitz River. Additionally, the Program should include a downstream migrant collection facility for any low-head hydroelectric project constructed above Mossyrock pool to allow re-establishment of anadromous fish runs in the upper Cowlitz River.

FLOW REGULATION SCHEDULE
FOR
MAYFIELD POWER PLANT

A. March 1 - July 15

Minimum flow releases from Mayfield Dam to be 5,000 cfs unless the March 1 or later forecasts indicate that this flow cannot be achieved and meet reservoir refill requirements. If the forecasts indicate that 5,000 cfs cannot be achieved, every concerted effort will be made to maintain as high and as constant a release as possible. Date of commencement to be March 1, dependent upon observations or predictions of the emergence of salmonid fry made by the Departments of Game and Fisheries.

B. July 16 - September 15

Minimum flow releases from Mayfield Dam to be 2,000 cfs during this period. The 2,000 cfs is to be a constant flow. If circumstances beyond the control of the City of Tacoma require the release of greater amounts of water, then reductions in rate of flow shall be equal to or less than the rate of change of natural flow into Mayfield Reservoir.

C. September 16 - November 20

Every concerted effort will be made to maintain a flow regime between 2,500 and 4,000 cfs at Mayfield Dam. Should circumstances beyond Tacoma's control make it necessary to exceed the 4,000 cfs flow level, then, if possible, subsequent discharges will be provided to adequately cover existing salmon redds. Spawning flows will apply through November 20 or until completion of spawning, whichever comes first. The Washington Department of Fisheries will make spawning surveys each season and notify the City upon completion of spawning.

D. November 21 - February 28

Minimum flow releases from Mayfield Dam will be maintained at a level that will inundate existing redds except when conditions are beyond the licensee's control.

The flows and dates set forth above are the best available and are established with the understanding they can be modified by mutual agreement based on ongoing observations and studies. Good communication between all parties is essential to provide maximum operating flexibility and maximum benefit to the fishery resource of the Cowlitz River.

ACCEPTED:

DEPARTMENT OF GAME:

BY _____ DATE Nov 21, 1977
Ralph W. Larson, Director

DEPARTMENT OF FISHERIES:

BY _____ DATE Nov. 29, 1977
Gordon Sandison, Director

CITY OF TACOMA:

BY _____ DATE November 16, 1977
A.J. Benedetti, Director
Department of Public Utilities

Task 3.2.4: Lewis River

The North Fork Lewis River downstream of Merwin Dam contains considerable habitat for the production of anadromous fish. Currently, the North Fork supports an excellent run of fall chinook salmon and a fair run of coho and steelhead. Spring chinook have been recently reintroduced to the North Fork via hatchery plants and some natural production of this race has developed.

Historically, the North Fork produced excellent runs of spring and fall chinook, coho, and steelhead trout. The three large hydroelectric projects on the river have eliminated most of the natural production area. Loss of this salmon production habitat has been compensated by hatchery production although the project owner, Pacific Power and Light (PP&L), does not pay their full share of the compensation requirement. Discussions between the Washington Department of Fisheries and Game and PP&L are continuing in an effort to have PP&L meet their mitigation responsibility.

Prior to accepting hatchery production as a sole form of compensation, the upper North Fork was investigated for natural production possibilities. Specifically, Merwin Reservoir was studied to see if it was suitable as rearing habitat for salmonids. Experiments involving coho salmon were conducted in the 1960's indicating that the reservoir was not suitable for rearing due mainly to the effects of predation (Hamilton, et al., 1970).

Natural production of anadromous fish is now confined to the lower North Fork below Merwin Dam. Flow releases at Merwin have, at times, adversely affected downstream production. The licensed minimum flow at 760 cfs is not adequate for spawning, incubation, or rearing. Flow fluctuations during the spring and early summer months have created conditions that strand large numbers of salmon fry (Phinney, 1974).

Beginning in 1977, steps were taken to lessen the flow-related impacts caused by Merwin Dam. A modified flow regime was developed by PP&L and the Washington Department of Fisheries that reduced the possibility of

stranding juvenile fish. However, this flow regime only addressed the needs of fish during the early rearing period. Fishery flow requirements for the remainder of the year were subsequently examined through field investigations. The results of this information is now being used to prepare an annual flow regime at Merwin Dam. For the past year PP&L and Washington Departments of Fisheries and Game officials have endeavored to work out an agreed upon plan whereby a flow schedule is developed that would adequately protect the natural production of fish while not unduely restricting PP&L operations.

Progress is beind made; for example, an experimental spawning flow regime will be implemented during the fall of 1981 which is designed to maximize conditions for fall chinook spawning and help minimize incubation problems.

Still to be resolved are problems involving flow fluctuations (frequency and range), and minimum flows for rearing salmonids. Discussions regarding these particular problems are now in progress. It is hoped that in the near future, a year-round flow program will be instituted which will greatly improve the natural production of the fisheries resource in the lower North Fork Lewis River.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program a flow regime (to be finalized in the near future) that provides productive conditions for anadromous fish below Merwin Dam.

Task 3.2.5: Clearwater River

The operation of Dworshak Dam and Reservoir has created considerable changes in the aquatic habitat downstream from the dam. These changes include frequent and rapid fluctuations in flow due to daily and seasonal power peaking and an altered temperature regime.

In order to provide adequate opportunity for to harvest opportunities on returning adult steelhead, the following flow regime should be followed at Dworshak Dam: (from project EIS and Reservoir Regulation Manual)

1. Fall steelhead season

   A. The prime steelhead fishery below the project generally occurs within the period of October 1 to November 15. Low steady flows during this period are beneficial to steelhead fishing and releases from Dworshak Dam should not exceed more than 1,300 cfs over inflow. Daily fluctuations should be kept to less than 20 percent of the weekly average flow.

   B. The period of November 16 to December 31 can also be an important part of the steelhead season, depending on weather conditions. Flow fluctuation should be kept to a minimum during this time while flows in the Middle Fork of the Clearwater River remain low to moderate. Higher constant flows rather than extreme daily peaking will increase fisher participation, distribution, and catch rates. Low, steady flows during the weekends should generally benefit steelhead anglers.

2. Spring steelhead season (January 1 - April 15)

   Same flow restrictions as in late fall period, except that the river directly below the project will become more important to steelhead

anglers, particularly when the Middle Fork of the Clearwater becomes high and muddy.

Dworshak Dam has the option of using discharge selector gates to vary the temperature of water released from the project. However, at present, water released are tied to the temperature needs of Dworshak National Fish Hatchery which requires extremely cool water during the summer months. Providing a separate water supply to the hatchery would make it possible to manage the river below Dworshak for optimum temperatures for wild resident and anadromous fish growth and reproduction. A study would be needed to evaluate the feasibility of this proposed action.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the above improved flow regimes below Dworshak Dam for efficient fisheries, and research funded by the Corps of Engineers to investigate the feasibility of a separate water supply system for Dworshak National Fish Hatchery to allow temperature regulation of the Clearwater River for optimal natural production.

Task 3.2.6(a): Yakima River-Roza Dam

Roza Dam is a concrete gravity structure located at R.M. 128 about 10 miles north of Yakima. The dam was built by the U.S. Bureau of Reclamation in 1939. The right bank diversion to Roza Canal provides a maximum of 2,200 cfs for irrigation and the generation of electrical energy at the Roza Power Plant.

The existing fish facilities consist of a left bank pool and notched weir fishway with an entrance from the right bank and rotary fish screens in Roza Canal. The facilities require extensive improvements. These include: (1) providing a readily accessible gate on the auxiliary water supply air vent, (2) converting to a vertical-slot type fishway which will allow efficient operation at all flows, (3) repair overflow gate so desired entrance velocity can be achieved, (4) extend protective screens covering fishway, (5) install counting board, and (6) upgrade the fish screening facilities to meet current screening design standards (see Task 1.4.7).

Additional fishery problems occur in the Roza wasteway which enters the Yakima River at R.M. 113 near the city of Yakima. Migrating adult anadromous fish are attracted by return flows from the Roza Power Plant. The fish swim upstream to the power plant where they are vulnerable to injury. A bar screen with provisions for self-cleaning should be installed at the mouth of the wasteway to exclude fish.

The fishery passage problems were detailed in the Bumping Lake Enlargement environmental impact statement.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the renovation and repair of adult and juvenile fish passage facilities at Roza diversion dam and installation of a barscreen mechanism at the entrance to the wasteway.

Task 3.2.6(b): Yakima River-Prosser Diversion Dam

Prosser Diversion Dam is a concrete gravity type structure on the Yakima River at R.M. 47 opposite the town of Prosser in Benton County. It originally was built to serve a flour mill on the right bank. In 1930 the Bureau of Reclamation purchased the dam and made alterations for the diversion from the left bank of 1,000 to 1,100 cfs of water to Prosser power plant constructed approximately 2 miles downstream. In 1955 the Bureau of Reclamation abandoned its Prosser power plant and started modification of the dam and diversion to deliver 1,500 cfs of water to its newly constructed Chandler Plant, located 10 miles below the dam, where the water is used for irrigation and power generation.

Existing fish facilities include two concrete, vertical-slot fishways with auxiliary water supply systems. These facilities are functional, but a third ladder should be constructed at midstream. This fishway should be a double-slot structure with entrances on each side with a dual auxiliary water supply system. A cableway with a cable car is required for maintenance of the facilities.

The diversion canal has rotary fish screens with migrant bypass facilities. The screening facilities do not meet current screening design standards. Therefore, these facilities should be improved to meet current screening design standards.

The fish passage problems were detailed in the Bumping Lake Enlargement environmental impact statement.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of a vertical-slot fishway on Prosser Dam in the Yamima River.

Task 3.2.7: White Salmon River

Anadromous fish resources of the White Salmon River were adversely affected by the construction of Condit Dam. The dam, currently owned by Pacific Power and Light (PP&L) is located at R.M. 3.3. Originally the dam was equipped with a wooden fish ladder which washed away a few years after the dam was completed. Another ladder was constructed; however, it also washed out and was not replaced. Therefore, upstream anadromous fish runs no longer exist.

Present runs of anadromous fish using the 3.3 miles of river below Condit Dam include fall chinook and coho salmon and steelhead trout. Fall chinook salmon are the dominant species with a 31-year average run of 2,800 fish. Also present are small runs of coho salmon and steelhead trout. Information related to the run size of these fish is very limited.

Operation of the project for power generation is as follows. Water at the dam is passed through penstocks to a powerhouse 1.3 miles downriver. Although the project license (Federal Energy Regulatory Commission No. 2342) requires maintenance of instream flows, several changes could be made to improve anadromous fish production within the system.

The most noteable improvement in anadromous fish production could be made by providing access to former production habitat above the dam. Both upstream and downstream passage facilities would be required as well as adequate flows for their operation. The Federal Energy Regulatory Commission has ordered PP&L to study the feasibility of provide fish passage past the dam. The study is now in progress and must be completed by September 1982. In addition to the PP&L study, Public Utility District No. 1 of Klickitat County (PUD) is funding fisheries studies required under their preliminary permit for the proposed White Salmon River (Federal Energy Regulatory Commission No. 2811).

The proposed objectives for the fisheries studies are as follows: (1) Classify, map, and quantify the amounts of existing fish habitat in the

project area; (2) determine potential anadromous salmonid production in areas upstream of Condit Dam; (3) determine present extent and importance of existing sport fishery in the river basin; (4) estimate numbers of resident fish in areas upstream of Condit Dam; (5) examine water quality, water quantity, and stream flows; (6) identify existing limiting factors on resident fish; (7) identify potential project-related impacts on fish and sport fishing and recommend mitigative procedures; (8) identify the relationship of streamflow to fish habitat using the U.S. Fish and Wildlife Service Instream Flow Study Group (IFG) methodology; (9) describe potential effects of superimposition of anadromous species on resident species; (10) determine the effects that the proposed project could have on the existing flow regime below Condit Dam; and (11) determine potential for change in water temperature in relation to the project with emphasis on Northwestern Lake.

Although detailed studies have as yet not been completed, it is estimated that with fish passage anadromous fish could be provided access to 30 - 40 miles of stream. The 1974 U.S. Bureau of Reclamation Appraisal Report for the White Salmon Division, Columbia North Side Project estimated production potential for 2,700 fall chinook salmon, 3,200 summer steelhead, and 200 coho salmon with dam removal. However, production for 1,500 of the fall chinook total was dependent upon breaching the dam and re-establishment of suitable spawning and rearing habitat in the river between the powerhouse and the inlet to the existing reservoir.

Existing anadromous fish production could be improved with stabilized and increased river flows below the powerhouse. The project operating license requires a minimum flow of 15 cfs to be maintained in the 1.3 miles between the dam and the powerhouse. Approximately 25 - 30 cfs are presently provided due to leakage past the dam. However, even this flow is not believed to be sufficient to provide available production potential. Spawning gravel is scarce within this reach; however, it is thought that juvenile steelhead trout and coho salmon use the area for rearing.

In the two miles of river from the powerhouse to the river's mouth, flow releases are almost always sufficient to sustain existing fish production. The project Federal Energy Regulatory Commission license limits flow fluctuations

to less than 2.5 feet within any 24-hour period during the months of September through mid-October. Specific data needs to be collected to determine acceptable fluctuation levels providing adequate fish protection. Data also needs to be collected to determine instream flow needs between the dam and powerhouse.

Detrimental flow fluctuations have occurred during emergency shutdown of the powerhouse. During these periods practically no flow is released causing fish losses. A system needs to be designed to provide an automatic turbine bypass pipe and outlet to prevent extreme flow fluctuations from occurring.

Recommendation: That the Power Planning Council provide programmatic support for the ongoing studies to determine improved anadromous fish production above and below Condit Dam and include in its Fish and Wildlife Program fish passage and improved instream flows should these and past studies indicate feasibility.

Task 3.2.8: Lower McKenzie River

Past studies have indicated fish production problems and adverse impacts on fishing due to Eugene Water and Electric Board's power diversions on the McKenzie River. These diversions remove up to 2,200 cfs and river flows may be reduced to 350 - 500 cfs in McKenzie River, the most important natural producer of spring chinook salmon in the Willamette system. The McKenzie is also one of Oregon's best natural producers of trout. Studies by Jensen and Mattson (1953) and Pulford and Jensen (1956) indicate greater flows are needed for fish production. Additional studies using current techniques should be conducted, upon which sound flow recommendations can be based.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program research to be conducted on the McKenzie River to determine necessary flows required to maintain anadromous fishery production.

Task 3.2.9: Upper McKenzie River

Operation of the Corps of Engineers' Cougar and Blue River Dams in the upper McKenzie River Basin greatly affect flows and stream temperatures in the McKenzie River. Studies at Cougar Dam (Ingram and Korn, 1969) showed that cold water released from the bottom of Cougar Dam inhibited the migration of adult spring chinook. Cold spring outflows are also known to inhibit growth of juvenile salmonids and therefore reduce their survival.

As part of the Corps of Engineers' Strube-Cougar Additional Power Study, fishery agencies proposed a restoration plan for the project to improve spring chinook production in the upper McKenzie and improve stream temperatures for fish. Part of this enhancement plan would be temperature control of the Cougar releases. Although the evaluation study indicated that Cougar releases inhibit spring chinook migrations into the South Fork, it has not been shown that Cougar influences migration into the main McKenzie above Leaburg. Unnaturally cold stream temperatures in the spring could affect fish detrimentally in at least three ways: by inhibiting upstream migration, by inhibiting downstream migration, and by reducing the growth rate of juvenile fish. Therefore, stream temperatures and spring chinook counts over a 20-year period were investigated to determine if a relationship existed between stream temperatures in the upper McKenzie and numbers of wild spring chinook produced. The review indicated that operation of Cougar and Blue River dams lowered spring and summer water temperatures in the South Fork McKenzie, Blue River, and mainstem McKenzie at Vida. June water temperatures at Vida are now averaging 4°F less than before construction of the projects. Since adult spring chinook will not readily migrate upstream below 52°F, the timing of the migration has been shifted to later in the summer. It is believed that this later migration results in abnormal distribution of adults with more fish remaining in the lower river.

The number of wild spring chinook produced in the upper McKenzie has dropped dramatically from the late 1950's to the present. While wild runs in the upper McKenzie has been substantially reduced, wild runs of spring chinook in other parts of the lower Columbia system and hatchery runs into

the Willamette have been stable or increasing. This information suggests that the primary cause of the reduction in the main McKenzie runs lies not in the ocean, or Columbia or Willamette, but in the upper McKenzie environment.

Two major changes in the upper McKenzie area that have taken place over the years are logging and dams. Much of the streamflow of the upper McKenzie comes from wilderness areas where the watershed has not been disturbed. Logging has taken place for many years in the McKenzie, but much of the area logged years ago is coming back with good cover. Therefore, we believe that logging and other development has not damaged the spring chinook habitat in proportion to the reduction in the runs.

It is well established that temperature affects growth rates of juvenile chinook. The average summer temperature in the main McKenzie decreased by 2°F after Cougar as compared to before. It is probable that the upper McKenzie after Cougar has produced smaller smolts that resulted in reduced survival. Further evidence of the growth affects of Cougar are that the trout at Leaburg Hatchery required more intensive growth management techniques in order to achieve pre-Cougar growth levels (John Andrews pers. comm.).

Temperature control facilities at Cougar and Blue River would take water from a range of reservoir depths and provide springtime temperatures near or better than before the projects were constructed. We believe the improved temperature regime would return runs of wild spring chinook in the upper McKenzie to their former abundance (6,800 fish), or an increase of 5,300 fish over the annual run of 1,500 fish escaping past Leaburg for 1974-77. This increased fishery production is valued annually at $2,470,000.

It is recommended that temperature control facilities be added to Cougar and Blue River dams. The benefits would include the 5,300 wild spring chinook mentioned above and also additional summer steelhead, resident trout, and fall chinook.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the installation of temperature control facilities in Cougar and

Blue River dams by the Corps of Engineers to restore the runs of spring chinook and other fish species in the McKenzie River.

Task 3.2.10: North Santiam River

Unpublished data developed by the Oregon Department of Fish and Wildlife indicates that there are serious delays in adult migration and poor fish production in the North Santiam River below Detroit Dam because of the very low temperatures of reservoir releases. This problem could be resolved by retrofitting the dam with multi-level temperature control facilities that would allow selection of optimal stream temperatures for maximum productivity.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program research to investigate the feasibility of installing temperature control facilities on Detroit Dam and the installation by the Corps of Engineers of such facilities, if so indicated by the feasibility studies.

Subobjective 3.3: Enhance habitat offsite to compensate for anadromous fish populations directly affected by power development.

To compensate for losses occurring at hydroelectric dams due to construction and operation, opportunities exist on many tributaries for habitat enhancement. Significant increases in production and contribution to fisheries can be achieved through improvement of habitat. Enhancement of tributary habitat has been carried out by the U.S. Forest Service on the Entiat River through the use of spawning channels and on the Sawtooth National Forest through the screening of irrigation diversions. Fishery agencies also have considerable experience in habitat improvement efforts. Examples include riparian restoration, gravel cleaning or replacement, and instream flows.

A portion of the compensation for unavoidable passage losses should be achieved through habitat improvement projects. Many projects are identified herein. These and others could be undertaken immediately with funding.

Because of the inability of the fishery community to secure enhancement funds, programs have not been instituted. Yearly revenues should be provided under the Power Planning Council's Fish and Wildlife Program to initiate enhancement beginning with those projects currently identified.

Task 3.3.1: Establish a process which identifies and justifies site-specific habitat improvement projects that resolve limiting production factors.

Vast potential exists for improving salmon and steelhead runs with offsite habitat improvement projects. Many of these projects have been identified in previous planning processes but have not been constructed due to lack of funds. Many of these projects are now included herein as a means of compensation for power-related losses.

Inumerable other projects are possible but require clear identification, calculation of potential fishery benefits, determination of construction costs, appropriateness for fisheries compensation program, and solutions to potential institutional barriers. A thorough inventory of additional habitat projects that can help attain planned species compensation goals is required. As with other compensation measures, priority should be given to projects which would increase production of those fish stocks most severely impacted by the power system.

A team of fishery habitat biologists and engineers should be established and provided two years to catalog the most necessary and feasible habitat improvement projects.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the establishment and funding of a biological and engineering team to inventory and develop feasible habitat improvement projects for funding with power revenues.

Task 3.3.2: Yakima River-Bumping Lake Enlargement

Introduction: An estimated 600,000 salmon and steelhead annually migrated into the Yakima River system prior to 1880. By 1980, the escapement had declined to a total of approximately 11,000 fish: 3,000 spring chinook; 1,000 fall chinook; 1,000 coho salmon; and 6,000 steelhead trout. The major overriding cause of this decline was the establishment of irrigated agriculture in the Yakima Basin and the associated construction of impassible storage and diversion dams, construction of unscreened irrigation intakes, and severe reductions of instream flows. Major problems that are continuing to contribute to declining anadromous fish runs in the Basin include the lack of adequate fish ladders and protective screens at diversion dams, and the lack of adequate spawning, incubating, and rearing flows. The Bureau of Reclamation's Bumping Lake Enlargement Project is a proposal to rectify these existing problems and to partially restore the anadromous salmonid runs in the Yakima Basin.

Bumping Lake is an existing manmade reservoir (actually an enlargement of a small glacial lake) located on the eastern slopes of the Cascade Mountains in eastern Washington. The lake serves as a storage reservoir for irrigation purposes in the Yakima River Basin. Water released from Bumping Lake for irrigation travels down Bumping, Naches, and Yakima rivers enroute to actual farm delivery. Presently, Bumping Lake has a maximum water surface area of 1,300 acres. The active storage volume of the lake is 33,700 acre-feet, and the average annual inflow to the lake is approximately 200,000 acre-feet.

With the Bureau's project, a number of construction and operation features would be initiated; foremost among them would be the enlargement of existing Bumping Lake Dam. The enlarged lake would have a maximum surface area of 4,120 acres and an active storage capacity of 458,000 acre-feet. Other project features considered to be integral parts of the Bumping Lake Enlargement Project include improving fish passage and protective facilities at existing barriers in the Yakima Basin watershed and construction of hatchery facilities to accommodate stocking programs.

The Bumping Lake Enlargement Project is a multipurpose project that would provide benefits to the functions of fish and wildlife enhancement, irrigation, recreation, flood control, and area redevelopment. One of the major specific purposes of this proposed project would be to enhance anadromous fishery resources. Approximately 70 percent of the project-justifying benefits have been assigned to this project function. The primary enhancement measure which would result in fishery enhancement would be to provide instream flows in various stream reaches throughout the Yakima Basin during annual critical periods. Although the enlarged reservoir would not refill to its total active storage capacity each year due to the lack of sufficient runoff, 324,300 acre-feet of the new volume would be earmarked as an annual "water account" for fishery maintenance throughout the Yakima River Basin. Water needed solely for fishery maintenance could be released from any Bureau of Reclamation reservoir in the Yakima Basin with the amount of water used credited toward the 324,300 acre-foot account at enlarged Bumping Lake. Thus, the actual water stored at Bumping Lake might not be used for fishery purposes at all, but rather all Yakima Basin storage reservoirs would include potential flows for fish.

Because low- water years can be especially detrimental to fishery maintenance and enhancement efforts, Bumping Reservoir would be operated on a carryover basis so that water would be available for release in those low-water years. Water releases for the the fish function would be made in the fall and winter months when little or no irrigation releases are made and during the summer to maintain minimum flows past diversion points.

In addition to providing needed instream flows, the proposed project would greatly improve fish passage facilities and would promulgate a supplemental fish stocking program. Without implementation of all three of these programs, optimum enhancement of anadromous fish resources would not occur. Table 1 lists the passage facilities to be improved as part of the project.

A stocking program would be used to re-establish and increase fish runs over a period of up to 15 to 25 years, at which time natural production would be expected to maintain the runs. The hatchery facilities would possibly be used after this initial period to establish/re-establish runs elsewhere in the Yakima Basin. The location of hatchery sites has, as yet, not been determined. Possible locations include expansion of existing facilities at Klickitat, Goldendale, and Ringold Springs and construction of new facilities at Wenas Springs, on Wenas Creek, and Niles Springs and other springs along the Naches River.

The anadromous fishery objective of this project would be to greatly improve conditions in the Yakima Basin so that an annual escapement of 19,800 spring chinook, 4,600 fall chinook, 41,700 coho, and 21,200 steelhead would be

maintained. Based on 1979 prices, this level of escapement would result in annual sport and commercial fishing benefits of approximately $13,000,000.

Current Status: The Bureau of Reclamation has been studying the proposal to enlarge Bumping Lake for the past 25 years. Numerous other federal agencies and many state agencies, including National Marine Fisheries Service, Fish and Wildlife Service, Bureau of Indian Affairs, Washington Department of Fisheries, and Washington Department of Game, have contributed to these study efforts throughout the years. In 1968, the first formal report was sent to Cabinet levels indicating that the project was feasible. In 1976, a major restudy resulted in the formulation of a feasibility report that was submitted to Congress. In 1979, the final environmental impact statement was prepared and a project re-evaluation was submitted by the Bureau. The benefit-cost ratio for the project determined in that re-evaluation was 1.52 to 1.

During fiscal year 1980, U.S. Representative Mike McCormack sponsored H.R. 3489 to authorize the project and led the bill through subcommittee and committee into the full House. The bill was removed from the agenda as the fiscal year 1980 session neared completion. This was partly due to time constraints, but also partly due to opposition from some environmental groups that are concerned with protection of wilderness values above the reservoir. These groups apparently are still opposed to the project because of the expected loss of potential wilderness acreage due to inundation by enlarged Bumping Lake. In order to authorize the Bureau of Reclamation to construct the Bumping Lake Enlargement Project, the first step would have to be for a local Congressman to resubmit an authorization bill. U.S. Representative Sid Morrison has publicly indicated that he is considering such action.

Recently, Bureau of Reclamation initiated a feasibility study of the proposed Yakima River Basin Water Enhancement Project (YRBWEP). This proposed project, like the Bumping Lake Enlargement Project, is aimed at providing additional water storage capacity in the Yakima Basin to provide improved instream flows for fishery resources and to provide water for other purposes such as irrigation and recreation. Potential increased storage sites for the YRBWEP include enlarging Bumping Lake, as well as constructing numerous new dams in the watershed. Thus, Bumping Lake could be enlarged via two alternatives, through authorization of the proposed Bumping Lake Enlargement Project or as an integral feature of the proposed YRBWEP if it is authorized. It should be noted that authorization of the YRBWEP will not even be considered for at least five years.

Many interrelated activities are ongoing in the Yakima Basin pertinent to this discussion about Bumping Lake enlargement. These activities must be considered in order to accurately understand the present situation.

The State of Washington is presently in the process of adjudicating water rights in the Yakima Basin. Associated with this, the Bureau of Indian Affairs has funded the Fish and Wildlife Service to conduct an instream flow study in the Yakima Basin using the Instream Flow Group-4 Methodology. This study will more accurately quantify the instream flow requirements of anadromous fish in the watershed.

Numerous hydroelectric production proposals are being investigated in the Yakima Basin by private firms and the federal government. Most of these proposals involve utilizing the existing flow regimes at existing reservoirs.

Thus, a third major variable, in addition to irrigation and fishery interests, may soon complicate the issue of allocating the scarce water resources in the Basin.

Court proceedings during the winter of 1980-81, presided over by Judge Quackenbush, brought to the surface that adequate fish flows are needed and indeed are mandated in the Yakima Basin, and that water demand in the Basin exceeds the available stored supply. The result of that court action was that flows were required to be released for protection of fish resources during 1980-81, and the involved resource agencies and entities were required to develop long-range solutions to the water use conflicts.

All of the above-discussed items point out the tremendous need for increased storage in the Yakima Basin. The Bumping Lake Enlargement Project, if constructed, would be an important step toward satisfying the multipurpose demands for more water in the Yakima Basin.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of the Bumping Lake Enlargement Project.

Table 1. Improvements to fish passage and protective facilities in the Yakima Basin proposed as features of the Bumping Lake Enlargement Project.

Diversion Dam or Canal	Location	Type of Improvement
Horn Rapids Diversion Dam	Yakima River, 18 miles upstream from mouth	Replace left and right bank ladders
Prosser Diversion Dam	Yakima River near city of Prosser	Add midstream ladder
Sunnyside Diversion Dam	Yakima River, about 1 mile north of town of Parker	Replace midstream and right bank ladders and add new ladder on left bank
Wapato Diversion Dam	Yakima River, about 1 mile north of town of Parker	Replace right bank and midstream ladder and install one new ladder
Roza Diversion Dam	Yakima River, about 10 miles north of of city of Yakima	Rehabilitate fish ladders and screens
Town Diversion Dam	Yakima River near city of Ellensburg	Install new ladder and screen
Easton Diversion Dam	Yakima River near town of Easton	Replace existing ladder and screen
Old Reservation Canal	Yakima River, diverts just upstream from Sunnyside Diversion Dam	Install screen
Thorp Mill Ditch	Near Ellensburg	Install screen

Task 3.3.3(a): Yakima River-Horn Rapids Dam

Horn Rapids Dam is of timber crib construction, at R.M. 18 on the Yakima River. The dam was built near the turn of the century by the Lower Yakima Irrigation Company.

A right bank diversion to Columbia Canal has a maximum capacity of 320 cfs, and a left bank diversion to the Richland Canal has a maximum capacity of 300 cfs. Both canal companies share in operation of the dam.

Presently, there are not passage facilities for upstream migrants. A hydraulic height of four feet permits fish to swim over the dam at high flows, but during low to moderate flows, fish passage is difficult to impossible. Two concrete vertical-slot fishways should be constructed to provide fish passage over a wide range of flows.

Both diversion canals have rotary fish screens with migrant bypass facilities. The screening facilities do not meet current screening design standards. Both screening facilities should be improved to meet current screening design standards.

The fish passage problems were detailed in the Bumping Lake Enlargement environmental impact statement.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of two vertical-slot fishways and improvement of fish screening facilities at Horn Rapids Diversion Dam on the Yakima River utilizing power revenues.

Task 3.3.3(b): Yakima River-Sunnyside Dam

Sunnyside Dam is a concrete gravity structure on the Yakima River at R.M. 104 about one mile east of Parker. The dam was built in 1907 by the Bureau of Reclamation. A left bank diversion to the Sunnyside Canal provides a maximum of 1,320 cfs to the Sunnyside Irrigation District. The dam is operated by the Sunnyside District. Several hundred feet upstream from the dam, a right bank diversion to the Old Reservation Canal provides a maximum of 200 cfs to the Wapato Irrigation District.

Existing fish facilities include two pool and weir-type concrete ladders, one at midstream and one at the right bank, and a rotary screening installation with bypass provisions on the Sunnyside Diversion Canal. There are no fish screens on the Old Reservation Canal.

The existing fishways are inadequate for efficient adult fish passage. Three new concrete, vertical-slot fishways are proposed. A single-slot fishway should be located on each bank and a double-slot structure with two entrances should be strategically located with respect to the low-flow channel. All fishways should be designed to operate efficiently from minimum flow up to a river flow of 12,000 cfs. Auxiliary water systems should be provided for reach facility, with a dual system for the double-slot ladder.

The diversion canal has rotary fish screens with migrant bypass facilities. The screening facilities do not meet current screening design standards.

Therefore, these facilities should be improved to meet current screening design standards.

A rotary screen should be installed on the Old Reservation Canal.

The fishery passage problems were detailed in the Bumping Lake Enlargement environmental impact statement.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of three vertical-slot fishways and improvement of fish screening facilities at Sunnyside Diversion Dam on the Yakima River utilizing power revenues.

Task 3.3.3(c): Yakima River-Wapato Dam

Wapato Dam is a concrete, gravity structure located at R.M. 107 about 1 mile north of Parker. The dam was built in 1917 by the Indian Irrigation Service. The river divides into two branches (the east and west branch) immediately upstream from the dam and remains divided for 2 miles. A right bank diversion on the west branch to the Main Reservation Canal provides a maximum 2,000 cfs to the Wapato Irrigation Project, which operates the dam.

Existing fish facilities include two pool and weir-type concrete ladders, one at the right bank and one at midstream in the east branch and one rotary screening installation wity bypass provisions on the Main Reservation Canal.

The existing fishways on the east branch are inadequate for efficient adult fish passage. No fish passage facility exists on the west branch.

Both east branch fish ladders should be replaced with concrete vertical-slot installations. The midstream ladder, accessible from left bank via cableway, should be a double-slot structure with fish entrances on each side. A single-slot ladder should be provided at all three fishways, with a dual system for the double pool midstream installation. All three fishways should be designed to operate efficiently in flows ranging from no spill to 13,500 cfs.

The diversion canal has rotary fish screens with migrant bypass facilities. The screening facilities do not meet current screening design standards.

Therefore, these facilities should be improved to meet current screening design standards.

The fish passage problems were detailed in the Bumping Lake Enlargement environmental impact statement.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of three vertical-slot fishways and improvement of fish screening facilities at Wapato Diversion Dam on the Yakima River utilizing power revenues.

Task 3.3.3(d): Yakima River-Ellensburg-Town Dam

Town Dam is a timber-aproned, concrete gravity structure at R.M. 161 on the Yakima River near Ellensburg. The dam was built about 1929 by the Washington Department of Highways as part of a highway relocation project. A left bank diversion to the Town Canal provides a maximum of 100 cfs. The dam is operated by the Ellensburg Water Company.

Existing fish facilities consist of a rotary screen installation with bypass provisions on the Ellensburg-Town Canal about a half-mile downstream from the headworks. This facility requires extensive annual maintenance because of the screen location and length of the bypass. There are currently no fishways, making adult fish passage at moderate to low flows difficult to impossible.

A vertical-slot fishway is proposed for the right bank and fish screens and bypass should be relocated near the headworks.

The fish passage problems were detailed in the Bumping Lake Enlargement environmental impact statement.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of a vertical-slot fishway and an evaluation of relocation of juvenile fish screens at Ellensburg Town Diversion Dam on the Yakima River utilizing power revenues. If evaluation findings indicate that screening is necesssary, funding of construction should occur.

Task 3.3.3e: Yakima River-Easton Dam

Easton Dam is a concrete gravity structure with a movable crest consisting of a single drum gate, on the Yakima River at R.M. 202 near Easton. The dam was built in 1929 by the Bureau of Reclamation. A right bank diversion to the Kittitas Main Canal provides a maximum of 1,300 cfs. The dam is operated by the Kittitas Reclamation District.

Existing fish facilities include a concrete pool and weir-type ladder on the left bank and a bar-screen installation on the Kittitas Main Canal. Problems with the fishway include: excessive drop between pools, undesirable high velocities and turbulence at the fishway exit, poor entrance location, and inadequate attraction flow. The bar-screen installation on the diversion is totally inadequate to protect downstream migrants.

The proposed facilities include a new vertical-slot fishway. The fishway should have two entrances to provide access at all flows with an auxiliary water supply to maintain desirable fishway entrance velocities and adequate transportation velocities through the inundated portions of the fishway at high tailwater elevations. The new structures should have two exits into the reservoir to operate under both raised and lowered spillway gate conditions.

The bar-screen installation in the Kittitas Canal should be replaced with a rotary-type structure with provision for a bypass.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of a vertical-slot fishway and fish screen facilities at Easton Diversion Dam on the Yakima River utilizing power revenues.

Task 3.3.3(f): Yakima River-Snipes and Allen Canal

The Snipes and Allen Canal diversion located on the Yakima River at R.M. 97 near Buena, currently has a rotary fish screen and bypass system. The bypass does not operate adequately at higher river flows. The existing bypass should be replaced with a system that will function efficiently at all river levels. This canal diverts a maximum flow of 40 cfs.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program replacement of the fish bypass facilities at The Snipes and Allen Canal on the Yakima River utilizing power revenues.

Task 3.3.3(g): Yakima River-Thorp Mill Ditch

This is an earthen ditch with a wing dam which diverts up to 112 cfs from the Yakima River at R.M. 164 near the city of Thorp. Presently there are no juvenile protection facilities.

The ditch should be screened with a rotary-type structure.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of fish screening facilities at Thorp Mill Ditch on the Yakima River utilizing power revenues.

Task 3.3.3(h): Yakima River-West Side Ditch

This is an earthen ditch which diverts 100 cfs from the Yakima River at R.M. 166 near the town of Thorp. The diversion canal has rotary fish screens with migrant bypass facilities. The screening facilities do not meet current screening desigh standards. Therefore, these facilities should be improved to meet current screening design standards.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of a fish screening facility at West Side Ditch on the Yakima River utilizing power revenues.

Task 3.3.3(i): Naches River-Naches/Cowiche Diversion Dam

This structure is located on the Naches River at R.M. 4 just upstream from the Highway 12 bridge. There are currently no fishways, making adult fish passage at moderate to low flows difficult to impossible. A vertical-slot fishway and fish counting facility is needed.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program construction of vertical-slot fishway and counting facility at Naches/Cowiche Diversion Dam on the Naches River utilizing power revenues.

Tasks 3.3.3(j): Yakima River-Toppenish Creek Flood Control Project

The Toppenish Creek Flood Control Project was constructed by the Bureau of Indian Affairs in the mid-1970's and is located approximately 3½ miles south of White Swan. It has a hydraulic height of approximately 8 feet. There is currently no fishway at this site which makes adult fish passage difficult to impossible.

The construction of a vertical-slot fishway is needed at this location.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of vertical-slot fishways on Toppenish Creek Flood Control Project utilizing power revenues.

Task 3.3.3(k): Toppenish Creek Diversion

This small dam diverts water from Toppenish Creek into the Satus Main Canal. It is located in T.10N., R.21E., Sec. 32. It has a hydraulic height of approximately 5 feet, and is owned and operated by the Wapato Irrigation District, Bureau of Indian Affairs. There currently is no fishway at this diversion and passage by anadromous fish is difficult to impossible. There is also no fish screening facility on the Satus Main Canal, which allows juvenile migrants to be swept into the Main Canal and lost.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program construction of vertical-slot fishway and fish screening facility at the Toppenish Creek Diversion utilizing power revenues.

Task 3.3.3(1): Yakima River-Marion Drain Diversion

This diversion leads water from Toppenish Creek into Marion Drain. It is located in T.10N., R. 18E., Sec. 22 and is owned and operated by the Wapato Irrigation District, Bureau of Indian Affairs. There currently is no fish screening facility at this site which allows juvenile migrants to be swept into Marion Drain and lost.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of a fish screening facility at the Marion Drain Diversion utilizing power revenues.

Task 3.3.4: Deschutes River Tributaries

Current Status: Based on the May 1981 Fish and Wildlife Planning Aid Report to the U.S. Bureau of Reclamation on the Deschutes River Basin the potential is great for increasing numbers of returning adult summer steelhead in Bakeoven, Buckhollow, and Trout Creeks. The report, prepared by National Marine Fisheries Service as part of Bureau of Reclamation's Eastern Oregon Anadromous Fish Habitat Restoration Project, outlined increases possible in these Deschutes River tributaries from flow increases and restored riparian vegetation. Headwater dams, if constructed, would provide needed flow increases in these streams and account for the following run size improvements over present levels.

Trout Creek	550 adult spawners
Bakeoven Creek	140 adult spawners
Buckhollow Creek	170 adult spawners

The inclusion of a vigorous riparian restoration program in conjunction with flow augmentation yields these figures for increased escapement:

Trout Creek	1,200 adult spawners
Bakeoven Creek	300 adult spawners
Buckhollow Creek	390 adult spawners

The feasibility of constructing these small headwater impoundments is doubtful as indicated by preliminary cost analysis by the Bureau. National Marine Fisheries Service and Fish and Wildlife Service have now developed figures for fishery benefits for riparian restoration without additional water storage, and believe that this program is a third alternative in the Deschutes Basin. It is less capital intensive than dam construction and would provide for greatly improved anadromous fish habitat on these streams. The estimates for increased escapement due solely riparian improvements are:

Trout Creek	1,300 adult spawners
Bakeoven Creek	180 adult spawners
Buckhollow Creek	410 adult spawners

The report to the Bureau of Reclamation also evaluated the potential for providing fish passage at the falls on White River. The assessment, based on earlier stream surveys by Oregon Department of Fish and Wildlife, concluded that from 500 to 1,600 steelhead and 400 fall chinook adults could migrate to and spawn in the upper White River drainage if passage were provided.

The mainstem of White River could possible support twice this number of steelhead spawners if means were devised to trap silt entering the river from glaciers on Mt. Hood.

Comparison of annual steelhead benefits to costs for the riparian improvement work indicates good feasibility. Other benefits would also be generated through improved wildlife populations, improved water quality, and reduced bank erosion.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the implementation of riparian restoration on Bakeoven, Buckhollow, and Trout Creeks utilizing power revenues, and feasibility study of passage at White River Falls in the Deschutes River Basin.

Task 3.3.5: Fish/Wash Creek Project - Clackamas River

Introduction: Fish creek is a major tributary to the Clackamas River. Wash Creek is a major tributary to Fish Creek. This system is considered to be one of the major producers of coho salmon and winter and summer steelhead trout in the upper Clackamas system. Flooding in the mid-1960's removed much of the channel structure necessary to maintain spawning habitat. Surveys have indicated over 50 percent of the spawning habitat has been eliminated. In addition, road building and timber harvest have reduced stream shading on the upper drainage to the point where summer water temperatures on the lower drainage are marginal (65° - 70°F) for salmonid rearing.

Proposal:

First Year

A. Construction

Install spawning gravel catchments at three sites on Wash Creek and five sites on Fish Creek immediately below the confluence with Wash Creek. Combinations of rock/boulder berms and gabions will be utilized.

B. Costs

Construction		$30,000
Administration		3,000
Overhead at 26 percent		8,600
	SUB (1)	$41,600

C. Results

It is estimated this project will create approximately 500-700 yd^2 of additional spawning habitat. This would represent an 80 percent increase in available spawning habitat. This additional habitat will support approximately 200 pair of coho and 200 pair of steelhead spawning adults.

Second Year

A. Planting

Perform site preparations and plant combination of red alder (bare root seedlings gathered locally), willow, and cottonwood on approximately 22,000 lineal feet (approximately 20 acres) of mainstem and major perennial stream channel. Plantings will be in a zone from 20 to 60 feet wide depending on stream width and aspect at each site. Release and replanting will be needed during years 3 and 4 on approximately 30 percent of the area.

B. Costs:

Site preparation (10 AC at $400/AC)		$ 4,000
Planting contract 20 at $300/AC		6,000
Replant (6 AC at $200/AC)		1,200
Release (2 yr, 10 AC at $250/AC)		2,500
Administration (years 1 and 2)		1,500
Overhead at 26 percent		4,000
	SUB (2)	$19,200
	SUB (1)	$41,600
	SUB (2)	$19,200
Total Project Cost		$60,800

C. Results

Within 5-10 years this revegetation work will result in about a 5°F reduction of mainstem summer stream temperatures in the lower 3-4 miles of Fish Creek. This temperature reduction will allow full utilization of the rearing habitat in the area. This project will be very complimentary with the upstream spawning habitat improvement work.

Estimated annual value of benefits (minimum): $65,000

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of the Fish/Wash Creek Project utilizing power revenues.

Task 3.3.6: Lake Branch Habitat Project - Hood River

Introduction: The Lake Branch is a major tributary to Hood River and is the major producer of both winter and summer steelhead in this system. Presently, the system is not producing at full potential due to a variety of features. First, a 12-foot falls at R.M. 0.9, in bedrock, is partially blocking upstream access. Passage is particularly difficult during low flow. Annual blasting is required to maintain existing access. Erosion and headward migration of this falls (1 - 2 feet/year) are primarily responsible. Another 4-foot falls/bedrock chute at R.M. 2.8 is also creating passage problems, particularly during low flows. Both of the previously mentioned obstructions are in private ownership. Log jams create additional passage obstruction at R.M. 3.9, 6.8 and 7.2. Rearing and holding habitat is of reduced quality between R.M. 4.9 and 6.5. Limited pool depth and cover are primarily responsible. Finally, between R.M. 7.7 and 8.6 a variety of conditions, including greatly reduced shading, lack of channel structure, and severe erosion and widening of the channel, have substantially reduced the quality and quantity of spawning and rearing habitat.

Proposal:

Phase 1

A. Construction

Oregon Department of Fish and Wildlife will take the lead in providing long-term corrections for passage problems on private ownership. A passage design consultant will be utilized to develop a design correct passage problems at the lower falls. The Forest Service will take the lead in correcting passage problems on the National Forest through partial removal of the existing jams.

B. Costs

Design consultant (ODFW)	$10,000

Correct lower falls (year 2) est.	70,000
Correct upper falls (ODFW)	3,000
Partial removal 3 jams (USFS)	15,000
Administration (ODFW)	3,000
(USFS)	2,000
Overhead (USFS at 26 percent)	4,400
SUB (1) (ODFW)	$86,000
SUB (2) (USFS)	21,400
	$107,400

Phase 2

A. Construction

A variety of techniques, including boulder placement, rock berms, gabions, and log sills, will be utilized to increase the quantity and quality of rearing and holding habitat between R.M. 4.9 and 6.5. Based on recent survey data it is estimated that improvement work will be applied at approximately 20-25 sites. A design consultant will be utilized during the first year to assist in matching specific improvement techniques to individual sites. Construction will occur during year 2.

B. Costs

Planning (year 1)	$ 3,500
Consultant (year 1)	5,000
Construction (year 2)	30,000
Administration (year 2)	2,500
Evaluation (year 1-4)	25,000
Overhead (26 percent)	17,000
SUB (3)	$73,000

C. Results

It is estimated that a 15 percent increase in smolt production potential will result from improvement work. Detailed monitoring of the area will attempt to document results of this work.

Phase 3

A. Construction and Planting

This will focus on rehabilitating habitat between R.M. 7.7 and 8.6. Streamside plantings of alder and cottonwood will be utilized to increase shading and provide a seed source for downstream areas. Planning will determine specific techniques to be used to increqse channel structure and greatly minimize channel erosion. Construction work will occur during years 2 and 3 of this phase.

B. Costs

Site preparation (5 AC at $400/AC)	$ 2,000
Planting (10 AC at $250/AC)	2,500
Planning	3,500
Consultant	7,000
Construction (year 2) est.	40,000
(year 3) est.	17,000
Administration (years 2 and 3)	4,000
Overhead	20,000
SUB (4)	$96,000

C. Results

Moderate to high quality spawning and rearing habitat will be provided through this 0.9 mile stretch. Currently the production potential of this habitat is rated as generally low. It is believed that a 50 percent increase in smolt production can occur from this work.

Total Costs: Phases 1, 2, and 3

SUB (1)	$ 86,000
SUB (2)	21,400
SUB (3)	73,000
SUB (4)	96,000
	$276,400

Estimated annual value of benefits - 3 phases (minimum): $133,000

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of the Lake Branch Habitat Project utilizing power revenues.

Task 3.3.7: Fisheries Habitat Improvement - John Day River System

Introduction: The John Day River is a large system with high potential for production of salmon and steelhead. The system contains one of the few remaining totally wild runs of spring chinook and summer steelhead in Oregon. However, production of these fish is currently relatively low due to natural habitat limitations such as a shortage of pool areas and to habitat degradation caused by gold dredging, cattle grazing, etc. It is feasible to greatly increase production of anadromous smolts by improving stream habitat. Successful techniques for this purpose have been developed, used, and evaluated.

The approach to solving the problem of insufficient fish rearing habitat is through direct structural habitat improvement. Installation of single log weirs to form pools ideal for juvenile rearing space is, in many cases, the most cost effective means found to date. By placing the weirs in series, the area of pool habitat for rearing fish can be doubled. Additionally, gold dredged areas can be reclaimed and degradation of stream banks by cattle can be corrected through limiting access of cattle by fencing and by reconstituting stream banks.

Current management practices for timber harvest, range allotment planning, and road construction are aimed at minimizing impacts to fisheries habitat. Therefore, a program directed at improvement of habitat abused in the past to increase smolt production available from Malheur National Forest streams should be undertaken. Projects listed below should be considered individually rather than as a package. Construction would be under the supervision of the U. S. Forest Service (USFS).

Biologists have compared test (improved) and control (unimproved) areas in various parts of the John Day system to evaluate the benefits of habitat improvement. This work has consistently shown that improved areas are producing five times the number of smolts found in unimproved areas. A fivefold increase in smolt production justifies the expenditures required to improve habitat.

3.3.7(A) Main Stem John Day River

Juvenile chinook and steelhead rear in the main stem of the John Day River. However, a forest survey completed in 1979 indicated that the mean percentage pool area was only 15.65%. The objective of this project is to provide additional rearing habitat for juvenile chinook and steelhead. This will be accomplished by installing 30 pool structures in the main stem John Day River.

Cost of this segment:

Environmental Assessment Report - completed

Construction - $30,000

3.3.7(B): Deer Creek, Tributary to South Fork John Day River

While Deer Creek has certain habitat limitations, it is an important steelhead producer in the John Day system. An ODFW survey indicated a pool:riffle ratio of 20:80, indicating rearing area is somewhat limited. USFS and ODFW personnel also agree that riparian vegetation is lacking and this is causing high water temperatures in the summer.

The objectives of this project are to provide additional rearing habitat for juvenile steelhead and to reduce summer water temperature maximums. These will be accomplished through installation of 200 pooling structures, protective fencing to limit access of grazing animals to stream banks and revegetation of riparian habitat.

Cost of this segment:

EAR - $3,500 - USFS appropriated funds

Construction - $230,000

3.3.7(C): Murderers Creek, Tributary to South Fork John Day River

Murderers Creek is an important steelhead producer in the John Day system, but produced better in the past prior to habitat degradation. An

ODFW survey indicated a pool:riffle ratio of 28:72 and a lack of stream shading.

The objective of this project is to provide additional rearing habitat for juvenile steelhead and reduce stream water temperature maximums. These will be accomplished through installation of 162 pooling structures, protective fencing to limit access of grazing animals, and riparian zone revegetation.

Cost of this segment:

EAR - $4,000 USFWS appropriated funds

Construction - $199,650

3.3.7(D): Fields Creek, Tributary to Main Stem John Day River

An ODFW survey showed that 2.5 miles of Fields Creek contains a pool:riffle ratio below an acceptable level. The objective of this project is to provide additional rearing habitat for juvenile steelhead through the installation of pooling structures.

Cost of this segment:

EAR - $2,000 USFS appropriated funds

Construction - $94,875

3.3.7(E): East Fork Beech Creek, Tributary to Main Stem John Day River

A survey by ODFW indicated that pool area constituted only 12% of the 8.75 miles surveyed. The objective of this project is to provide additional rearing habitat for juvenile steelhead by installing pooling structures.

Cost of this segment:

EAR - $3,000 USFS appropriated funds

Construction - $126,500

3.3.7(F): Clear Creek, Tributary of Middle Fork John Day River

An ODFW survey indicated a pool:riffle ratio of 17:83. The stream supports good quality riparian habitat and is considered overall a good quality stream. The objective of this project is to provide additional chinook and steelhead rearing habitat by installing 25 pooling structures.

Cost of this segment:

EAR - $1,500 USFS appropriated funds

Construction - $34,775

3.3.7(G): Squaw Creek, Tributary of Middle Fork John Day River

A forest survey indicated the pool:riffle ratio is 100% below optimum. In addition, juvenile chinook salmon rear in the stream above the principle spawning grounds. Most upstream movement is blocked by a road culvert.

The objective of this project is to provide additional rearing habitat for juvenile chinook and steelhead by installing 80 pooling structures and providing access through the road culvert.

Cost of this segment:

EAR - $1,500 USFS appropriated funds

Construction - $111,280

3.3.7(H): Canyon Creek, Tributary of Main Stem John Day River

An ODFW survey indicated a pool:riffle ratio of 24:76. The objective of this project is to provide additional rearing habitat for juvenile steelhead by installing 60 pooling structures.

Cost of this segment:

EAR - $5,000 USFS appropriated funds

Construction - $83,460

3.3.7(I): Middle Fork John Day River

The Middle Fork John Day River is an important production area for spring chinook and summer steelhead. There are insufficient holding areas for adult spring chinook in this stream.

The objective of this project is to provide 15 additional large holding areas for adult spring chinook. These areas will also be useful for holding adult steelhead and will provide rearing areas for both species.

Cost of this segment:

EAR - $2,000 USFS appropriated funds

Construction - $45,000

3.3.7(J): Big Boulder Creek, Tributary of Middle Fork John Day River

An ODFW survey showed a pool:riffle ratio of 23:77. The objective of this project is to provide additional rearing habitat for juvenile chinook and steelhead by installing 75 pooling structures.

Cost of this segment:

EAR - $4,000 USFS appropriated funds

Construction - $120,000

3.3.7(K): Granite Boulder Creek, Tributary of Middle Fork John Day River

An ODFW survey showed a pool:riffle ratio of 13:87. The objective of this project is to provide additional rearing habitat for juvenile chinook and steelhead by installing 100 pooling structures.

Cost of this segment:

EAR - $4,000 USFS appropriated funds

Construction - $160,000

3.3.7(L): Clear Creek, Granite Creek, Tributaries of North Fork John Day River

Fish habitat in Clear Creek was badly damaged several years ago by a gold dredging operation. Clear and Granite Creeks have good water quality but are lacking in pools for holding adult salmon and steelhead and rearing juveniles.

The objective of this project is to provide additional adult holding and juvenile rearing areas by installing 95 fish habitat structures (pooling structures and log deflectors to protect stream banks) in 4.5 miles of Clear and Granite Creeks.

Cost of this segment:

Construction $196,500

This project would be scheduled over a 3-year period with outlays as follows: First year - $70,000; second year - $65,000; third year - $61,500.

3.3.7(M): North Fork John Day River

The North Fork is the most important producer of anadromous fish in the John Day River system. During the 1940's gold dredging seriously damaged portions of the streambed in the North Fork.

The objective of this project is to open and restore an old stream channel blocked and damaged by gold dredging. This will increase and improve rearing of juvenile anadromous fish.

Cost of this segment:

Construction - $17,300

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program construction by the U. S. Forest Service of habitat projects in the John Day River system utilizing power revenues.

Task 3.3.8: Fisheries Habitat Improvement - Walla Walla River System

Headwaters of the Walla Walla River lie within National Forest boundries. The following two habitat improvement projects would improve anadromous fisheries. Work could be supervised and undertaken by the U.S. Forest Service utilizing power revenues.

3.3.8 (A): Touchet River, Tributary of Walla Walla River

The Touchet River was formerly a good producer of summer steelhead. Degraded habitat within the river added to fish passage problems at dams on the main Columbia River have reduced this population. With improved fish passage on the Columbia, the Touchet River habitat would become more productive.

This project consists of removing a round culvert which is causing a fish passage problem and installing an open arch type culvert. The project would increase use of existing underutilized habitat.

Cost of this segment:

Construction - $25,000

3.3.8 (B): South Fork Walla Walla River, Tributary of Walla Walla River

The South Fork Walla Walla River is naturally deficient in rearing pools for anadromous fish. The objective of this project is to construct pooling structures in three miles of the South Fork.

Cost of this segment:

Construction - $15,000

Recommendation; That the Power Planning Council include in its Fish and Wildlife Program the construction by the U.S. Forset Service of anadromous fish habitat improvement project in the Walla Walla River system utilizing power revenues.

Task 3.3.9: Fisheries Habitat Improvement - Grande Ronde River System

Headwaters of the Grande Ronde River lie within National Forest boundaries. The following habitat improvement projects would significantly improve anadromous fisheries. Work could be supervised and undertaken by the U.S. Forest Service utilizing power revenues.

3.3.9 (A): Phillips Creek, Tributary of Grande Ronde River

Phillips Creek is potentially a good producer of summer steelhead. However, due to water withdrawals, portions of Phillips Creek are dry during the summer months.

The objective of this project is to improve the riffle:pool ratio and develop pools that are deep enough to hold adults and rear juveniles during the summer months.

Cost of this segment:

Construction - $18,000

3.3.9 (B): Stream rehabilitation - Grande Ronde River

Numerous small tributaries of the upper Grande Ronde River and Joseph Creek have good potential for production of juvenile steelhead and, to a lesser extent, spring chinook. However, habitat degradation presently limits their production.

The objective of this project is to enhance riparian habitat through fencing to control activities of grazing animals, stream bank stabilization to prevent erosion, and revegetation to shade the streams and lower water temperature.

The streams requiring improvement and costs for each are:

Upper Grande Ronde Tributaries		Joseph Creek Tributaries	
Tributary	Cost	Tributary	Costs
McCoy Creek	$ 30,000	Peavine Creek	$ 33,000
Dark Canyon Creek	31,000	Elk Creek	34,000
Spring Creek	25,000	Devils Run Creek	34,000
Sheep Creek	24,000	Swamp Creek	34,000
Chicken Creek	20,000	Upper Chesnimnus Creek	47,000
Environmental assessment	15,000	Environmental assessment	15,000
Total	$145,000	Total	$197,000

Comparison of test (improved) and control (unimproved) areas have shown that production of anadromous fish smolts is increased by approximately five times due to improvement to stream banks and riparian vegetation.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction by the U.S. Forest Service of habitat improvement projects designated for the Grande Ronde River Basin utilizing power revenues.

Task 3.3.10: Entiat Riparian Vegetation Enhancement - Entiat River

Objective: To enhance anadromous fish habitat.

Project Description: The project is located between Burns and Fox Creeks along the Entiat River. Much of the riparian cover was removed by wildfire in 1970.

Present Situation: An unproductive stream has about 1,000 aquatic insects per square meter. Measurements between Burns and Fox Creeks indicate a population of less than 150 aquatic insects per square meter.

Project Proposal: Plant deciduous trees within the riparian zone for shading and insect drop. Seed areas of bare soil with grasses and legumes. Provide structural devices to slow stream flow (such as boulder placement), make meanders, create pools and provide objects with interstices for aquatic insect production. Examine the feasibility of stream enrichment with sucrose or other non-toxic substances.

Project Benefits: This project will increase the rearing capacity of the Entiat River for anandromous and resident fishes.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program implementation by the U.S. Forest Service of riparian and instream habitat improvement on the Entiat River utilizing power revenues.

Task 3.3.11: Fish Habitat Improvement - Warm Springs Indian Reservation

Introduction: The construction and operation of Columbia River dams has attributed to the decrease in anadormous fish runs migrating to and from the Deschutes River and it's tributaries. The waters of the Warm Springs Indian Reservation produce a large portion of the anadormous fish of the Deschutes River system. In recent history reservation streams have supplied over 120 miles of anadormous fish habitat. Currently only 80 miles of streams are producing fish and production is at low levels. Development of fisheries enhancement projects to increase production of anadormous fish on the Warm Springs Indian Reservation waters is critical.

Current Status: In 1977 the Warm Springs National Fish Hatchery was completed. The hatchery has potential to increase anadromous fish production throughout the reservation streams. This potential is pivotal on the level of future adult returns.

Currently the Bonneville Power Administration is funding a project to provide baseline data for the development of anadromous fish enhancement projects. The study is scheduled for completion by February 1982. The objective of this study is to gather, analyze, and compile pertinent information concerning reservation streams and their anadromous fish stocks. This information would detail physical and biological parameters specific to individual reservation watersheds.
Identification of areas where information is deficient will also be a task of the project. The watersheds on the reservation utilized by anadromous fish and being investigated under this project are; Shitite Creek, Beaver Creek, Mill Creek, Badger Creek, and the Warm Springs River.

Upon completion of the current study; additional data pertinent and prerequisite to the construction of anadromous fish enhancement must be compiled. Once this preconstruction information is developed, construction can be initiated. Following construction, monitoring of the enhancement result would be required.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program a study funded with power revenues to obtain necessary preconstruction data on anadromous fish enhancement projects on the Warm Springs Reservation and the funding and implementation of the projects following necessary study.

Task 3.3.12:: Fishery Habitat Improvement - Idaho

Many opportunities exist in the anadromous fish producing drainages of Idaho to increase the future production of salmon and steelhead. The four primary areas of enhancement include: 1) Effective screening of all diversion projects, 2) flow augmentation, 3) riparian habitat and channel improvement and 4) pollution abatement.

In some drainages the production capabilities of the streams could be more economically and effectively increased by developing incubation channels or actual rearing ponds rather than trying to enhance the entire drainage. These channels and rearing ponds would utilize hatchery eggs to supplement the limited wild production.

Potential sites for incubation channels or rearing ponds in the Clearwater drainage include Mission Creek, Lolo Creek, Newsome Creek, Red River, Crooked River, Selway River and the Lochsa River. Detailed information on the proposed sites is available in the files of the Idaho Department of Fish and Game.

3.3.12 (b): Pole Creek Fish Screen

Project Objective: Among fishery biologists familiar with the streams of the Sawtooth National Recreation Area (SNRA), Pole Creek is considered the highest quality fishery habitat within the SNRA. The stream has great potential to accommodate spawning and rearing of anadromous fish. Pole Creek is also a popular resident fishery.

Anadromous production has been eliminated by water diversion from seven points in the lower three miles of the stream for irrigation purposes. The total abstracted water rights (65.6 cfs) exceed the total flow instream throughout most of the irrigation season, leaving Pole Creek dewatered. A new plan to use a center-pivot sprinkler system rather than flood irrigation will draw only about 18 cfs from one point, leaving enough water instream to re-establish chinook and steelhead runs to Pole Creek. As an essential

component of cooperative efforts with the State of Idaho to re-establish anadromous stocks in Pole Creek, a fish screen on the 18 cfs diversion will be needed to protect downstream migrating smolts.

Initiation Date (estimated): As soon as possible, prior to June 1984.

Completion Date (estimated): As soon as possible, prior to August 1984.

Cost (Total): $28,000-$30,000

Project Benefit: The completion of this project would allow for effective utilization of 3 miles of stream above the diversion and 4.5 miles of stream below the diversion. It has been estimated that this habitat could sustain 625 spawning chinook and 1075 steelhead spawners. Using 1980 figures for economic value of chinook salmon ($294.23/spawning fish) and steelhead trout ($271.26/spawning fish), the annual dollar value of anadromous fish produced in Pole Creek is $475,498.

3.3.12 (c): Lapwai Creek

Stream Location: Lapwai Creek is 28 miles long and enters the mainstream Clearwater River at River Mile (RM) 11.8.

Problem: Lapwai Creek annually supports a few spawning steelhead, but low summer flows is a limiting factor to increasing steelhead production. Riparian degradation from livestock grazing has also contributed to stream temperature and sedimatation problems.

Species: Steelhead

Proposed Enhancement: Flow augumentation is needed to increase low summer flows and reduce stream temperatures, thereby increasing steelhead production potential.

Data Needs: An Instream Flow Group (IFG) incremental flow study has been conducted by the U.S. Fish and Wildlife Service, The only additional data

needed is fish standing crop data which would be correleated to flows to predict increases in fish biomass under the modeled flow regimes detailed in the FWS flow study report.

Identified by: Idaho Department of Fish and Game (IDFG), U.S. Fish and Wildlife Service (FWS), Nez Perce Tribe (NPT).

3.3.12 (d): Potlatch River

Stream Location: The Potlatch River is 52 miles long and enters the mainstem Clearwater River at river mile 15.1.

Problems: Dryland farming practices and logging in headwater tributaties have caused general sedimentation and low flows which cause temperature problems in the river. Much of the drainage is privately-owned wheat and cattle farms and riparian zone fencing is lacking.

Species: Steelhead

Proposed Enhancement: Extensive riparian rehabilitation, bank stabilization and livestock fencing are needed, mostly on private land. In addition, a flow augmentation project to increase low summer flows and decrease stream temperatures is needed. The Bureau of Reclamation is presently looking at the possibility of building a flow augumentation dam at Fry Meadows on the East Fork of Potlatch Creek.

Data Needs: An IFG flow study is needed to estimate increases to instream habitat available under augmented flow regimes. Correlations of various flows to fish standing crops would be developed from applicable data and/or from fish population surveys from a similar stream. Biomass data would be difficult to develop from surveys within this stream itself, because it is drastically underutilized. Stream surveys from the Potlatch would lead to estimates in the fish biomass predictions.

Identified by: IDFG, Idaho Department of Water Recources (IDWR), Idaho Department of Health and Welfare (IDHW).

3.3.12 (e): Clear Creek

Stream Location: Clear Creek flows into the Middle Fork Clearwater River at river mile 77.0. The Kooskia National Fish Hatchery is near the mouth of the creek.

Problem: The creek has numerous problems that adversely affect anadromous fish habitat, hatchery operations and general water quality. The problems are basin wide and difficult to pinpoint. Basically, intensive land use in the form of logging, grazing and farming has created the situation where any rain results in heavy silt loads downstream. There is also a low summer flow problem.

Species: Steelhead, spring chinook salmon

Proposed Enhancement: To re-establish anadromous fish habitat in the stream the following measures are needed: 1) flow enhancement for low summer flow and temperature control, 2) streambank protection, 3) channel rehabilitation, and 4) spawning ground improvements. Flow augmentation would require a headwater storage reservoir.

An extensive program, encompassing the above restorative efforts, would pay double dividends in this stream: enhancement of natural anadromous fish production protential and reduction of water quality problems at Kooskia NFH which have a direct impact on the hatcheries productive capabilities.

Data Needs: An instream flow study would be needed to predict increases to instream fish habitat that would result from flow augmentation. As the stream is drastically under utilized by anadromous fish, correlations of flows to fish biomass would probably have to be developed from "similar stream" data so as not to under estimate enhancement potentials.

Identified by: IDFG, FWS, IDWR

3.3.12 (e): Lemhi River

Stream Location: This 62-mile long river empties into the Salmon River at RM 251.

Problem: All water is appropriated for irrigation purposes, and thus it is fully diverted in low water years. Juvenile salmonid rearing and adult passage are adversely affected by the low flows.

Species: Chinook salmon, steelhead

Proposed Enhancement: Construct a storage dam and reservoir in the headwaters of this stream or a tributary to provide stored water for controlled release. The increased flows will enhance fishery habitat for juvenile rearing and adult passage

Data Needs: A reservoir site must be identified and analyzed. Detailed analyses of required flows must be competed using the IFG method. Estimates of increased fishery habitat and productivity must be determined by measuring standing crop and/or using historical data.

Identified by: IDFG - Salmon

3.3.12 (f): Alturas Lake Creek

Site Description: This upper Salmon River tributary enters the Salmon River about RM 390.

Problem: All of the Altures Creek flows are diverted to private pasture lands in many years. As a result, sockeye salmon passage to the lake has been blocked and this historically significant run has been eliminated. The diversion and resulting dewatering has reduced the upstream spring chinook spawning escapement by 60 percent and downstream juvenile chinook production by about 50 percent.

Species: Spring chinook and sockeye salmon

Proposed Enhancement: Contruct a 2-foot high, regulating dam at the natural outlet of Alturas Lake to store about 1600 acre-feet of water for release into the creek. The increased flows would allow 3000 to 6000 sockeye to be produced in Alturas Lake and 96 percent of the chinook to pass the diversion. Chinook production below the diversion would reach 80 percent of potential. Costs were estimted by the USFS to be $300,000 for the dam and screens and $75,000 for fish ladders.

Data Needs: Because of extensive analyses already completed, minimum field data will be needed. Cost and benefit analyses will be necessary.

Identified by: USFS, IDFG

3.3.12 (g): Carmen Creek

Stream Location: This 13-mile long stream enters the Salmon River about RM 246.

Problem: Low summer flows restrict anadromous fish use of this stream. All water is appropriated for irrigation purposes and anadromous fish runs have essentialy been eliminated.

Species: Chinook salmon, steelhead

Proposed Enhancement: Construct a storage reservoir in the headwaters of the stream for later release of water to augment flows and create suitable fishery habitat.

Data Needs: A storage site must be identified and detailed analysis of required flows must be completed using the IFG method. An analysis of past records and of anadromous fish productivity of a similar stream will be necessary to determine potential fish production under augmented flow regimes.

Identified by: IDFG - Salmon

3.3.12 (h): Lolo Creek

Stream Location: Lolo Creek enter the Clearwater River at river mile 54.1.

Problem: As a result of heavy logging several areas, in the approximately ten miles of stream indicated on the map, are in need of channel and riparian zone stabilization.

Species: Spring chinook salmon, steelhead

Proposed Enhancement: A stream rehabilitation project is needed to restore biolological productivity to this section of stream and increase it's production protential for anadromous fish. Instream rehabilitation options include boulder placement for cover and bank scouring protection and/or planted to stabilze the bank and provide cover for fish, Estimated cost is $50,000.

Data Needs: Identify specific reaches of the stream where stream habitat improvements would yield greatest results. Detailed surveys are needed to measure acres of instream habitat that could be enhanced with a riparian restoration project. Data to quantify expected increases to fish habitat and standing crops would be developed with fish population standing crop surveys and/or use of applicable data and information from similar streams.

Identified by: USFS - Clearwater N.F.

3.3.12(i): Red River

Stream Location: The Red River and American River converge at river mile 62.5 to form the South Fork Clearwater River.

Problem: A 9.5. mile section of the river in the Red River Meadows area has been severely impacted by livestock grazing; riparian areas have been denuded and physical damage has occurred to the streambed. These actions have tremendously reduced the fish production capabilities of the stream. This problem occurs on privately-owned land.

Species: Spring and summer chinook salmon

Proposed Enhancement: Fencing of this area to keep livestock out would allow the riparian zones to recover and greatly enhance the fish production potential of approximately 30 acres of stream habitat.

Data Needs: Identify specific reaches of the stream where stream habitat improvements would yield greatest results. Detailed surveys are needed to measure acres of instream habitat that could be enhanced with a riparian restoration project. Data to qantify expected increased to fish habitat and standing crops would be developed with fish population standing crop surveys and/or use of applicable data and information from similar streams.

Identified by: USFS - Nez Perce N.F.

3.3.12 (j): East Fork South Fork Salmon River

Stream Location: The East Fork flows into the South Fork Salmon River at RM 37.

Problem: The stream bank has been denuded from 5 to 10 miles below the old mining town of Stibnite since the mid-1960's when a dam failed.

Species: Spring chinook salmon, steelhead

Proposed Enhancement: A stream rehabilitation project is needed to restore biological productivity to the 5-10 miles of stream and increase it's anadromous fish production potentials. Riparian plant species would be planted to stabilize the bank and provide cover.

Data Needs: Detailed surveys are needed to measure acres of instream habitat that could be enhanced. Standing crops surveys will be made and combined with existing flow date to quantify expected increases in standing crops. Feasibility of establishing suitable plants will also be analyzed.

Identified by: USFS - Payette N.F.

3.3.12 (k): Camas Creek

Stream Location: This stream is about 38 miles in length and enters the Middle Fork Salmon River at RM 35.

Problem: Heavy livestock grazing in the Meyer's Cove area (RM 12) has degraded channel and riparian habitat conditions. Spawning and rearing habitat has been lost or reduced in quality.

Species: Spring chinook salmon, steelhead

Proposed Enhancement: A stream rehabilitation project is needed to restore biological productivity to the four miles of stream and increase it's anadromous fish production potentials. Fencing may be recommended and riparian species might be planted to stabilize the bank and provide cover.

Data Needs: Detailed surveys are needed to measure acres of instream habitat that could be enhanced with a riparian restoration project. Data to quantify expected increases to fish habitat and standing crops would be developed with fish population standing crop surveys and/or use of applicable data and information from similar streams.

Identified by: IDFG - Salmon

3.3.12 (l): Marsh Creek

Stream Location: This 14.5 mile long stream entes the Middle Fork Salmon River at RM 106.

Problem: Heavy livestock use has caused degradation of the stream between Knapp Creek (RM 10) and Cape Horn Creek (RM 6). Channel sloughing has occurred and the quality of riparian habitat has been reduced, which has reduced the anadromous fish production potential of this stream.

Species: Chinook salmon, steelhead

Proposed Enhancement: A stream rehabilitation project is needed to restore biological productivity to the four miles of stream and increase it's anadromous fish production potentials. Fencing may be recommended and riparian plant species might be planted to stablize the bank and provide cover.

Data Needs: Detailed surveys are needed to measure acres of increased habitat that could be enhanced with a riparian restoration project. Data to quantify expected increases to fish habitat and standing crops would be developed with fish population standing crop surveys and/or use of applicable data and information from similar streams.

Identified by: IDFG - Salmon

3.3.12 (m): Bear Valley Creek

Stream Location: This 37-mile long stream enters the Middle Fork at RM 106.

Problem: About 900 acres of land has been mined in the valley bottom, sedimentation from unstable stream banks has been a chronic problem. Livestock use has been heavy and has caused further loss of bank stability and riparian vegetation. The cummulative effect of these problems has reduced anadromous fish productivity.

Species: Spring chinook salmon, steelhead

Proposed Enhancement: The stream channel and surrounding area would be stabilized and riparian and other appropriate vegetation would be planted. Certain segments may be protected from livestock use by fencing.

Data Needs: Extensive data are available which will be sufficient to determine benefits. However, studies will be necessary to determine the appropriate reclamation techniques.

Identified by: USFS - Boise N.F., IDFG - Region III

Note: The area is privately owned and further mining could occur.

3.3.12 (n): Bear Valley Stream Channel Stabilization

Objective: Stabilize about 1 mile of stream channel that makes major channel changes each year and causes severe bank cutting. This cutting adds about 20,000 to 30,000 cubic yards of fine material annually to important chinook spawning habitat.

Beginning Date: 1984 - engineering
1985 - construction

Completion Date: 1986

Cost: $200,000

Benefit: Stabilizing streambanks on this mining property with gabions and riprap material will prevent the constant annual sedimentation of important salmon spawning and rearing areas in Bear Valley Creek. About 18 miles of stream will show a benefit from this project with an estimated 100,000 square yards of spawning gravel improved and 600,000 square yards of rearing area. The improved spawning and rearing space will increase smolt capability by an estimated 40 percent, or 75,000 smolts to the ocean.

3.3.12 (o): Elk Creek

Stream Location: This 22-mile long stream enters Bear Valley Creek at RM 11.

Problem: Heavy cattle use in the lower portion of the stream has degraded the stream banks and reduced riparian vegetation. The result has been a general reduction in water quality and anadromous fish production.

Species: Spring chinook salmon, steelhead

Proposed Enhancement: Fence cattle from certain stream reaches to allow vegetation recovery and bank stabilization. Riparian plant species may be planted if needed.

Data Needs: Identify specific reaches of the stream where stream habitat improvements would yield greatest results. Detailed surveys are needed to measure acres of instream habitat that could be enhance with a riparian restoration project. Data to quantify expected increases to fish habitat and standing crops would be developed with fish population standing crop surveys and/or use of applicable data and information from similar streams.

Identified by: IDFG - Region II

3.3.12 (p): Panther Creek

Stream Location: Panther Creek is 43 miles long and enters the Salmon River at RM 203.

Problem: Water seepage and leaching from the old Blackbird Mine and other mines have created a toxic environment for most aquatic life in Panther Creek. No anadromous fish redds have been observed in the creek since 1963.

Species: Spring chinook salmon, steelhead

Proposed Enhancement: A rehabilitation project is needed to restore biological productivity to several streams adversely affected by mining activities. Fencing may be recommended and riparian plant species might be planted to stabilize the bank and provide cover.

Data Needs: Detailed surveys are needed to measure acres of instream habitat that could be enhanced with a restoration project. Data to quantify expected increases to fish habitat and standing crops would be developed with fish population standing crop surveys and/or use of applicable data and information from similar streams. Appropriate techniques to reclaim the mines will have to be identified.

Identified by: IDFG - Salmon

3.3.12 (q): Lemhi River

Stream Location: This 62-mile long river empties into the Salmon River at RM 251.

Problem: Heavy grazing in various areas within the 24-mile reach from Leadore, Idaho (RM 62) to Lemhi has reduced the spawning and rearing habitat of anadromous fish.

Species: Spring chinook salmon, steelhead

Proposed Enhancement: A stream rehabilitation project is needed to restore biological productivity to an unknown number of miles of stream and increase the anadromous fish production potentials. Fencing may be recommended and riparian plant species might be planted to stabilize the bank and provide cover.

Data Needs: Detailed surveys are needed to measure acres of instream habitat that could be enhanced with a riparian restoration project. Data to quantify expected increased to fish habitat and standing crops would be developed with fish population standing crop surveys and/or use of applicable data and information from similar streams.

Identified by: IDFG - Salmon

Note: The area in question is privately owned.

3.3.12 (r): East Fork Salmon River

Stream Location: This 32-mile long stream enters the Salmon River at RM 336.

Problem: Heavy livestock use has degraded the streambank, channel, and riparian vegetation conditions for 8 to 10 miles of river from Herd Creek (RM

10.5) to Sheep Creek (RM 21). As a result, spawning and rearing areas for anadromous fish have diminished.

Species: Chinook salmon, steelhead

Porposed Enhancement: A stream rehabilitation project is needed to restore biological productivity to 10 miles of stream habitat and increase it's anadromous fish production potentials. Fencing may be recommended and riparian plant species might be planted to stabilize the bank and provide cover.

Data Needs: Detailed surveys are needed to measure acres of instream habitat that could be enhanced with a riparian restoration project. Data to quantify expected increases to fish habitat and standing crops would be developed with fish population standing crop surveys and/or use of applicable data and information from similar streams.

Identified by: IDFG - Salmon

3.3.12 (s): Yankee Fork Salmon River

Stream Location: This river is 25 miles in length and enters the Salmon River at RM 360.

Problem: About 5 linear miles of stream habitat (from Jordan Creek (RM 12) downstream) have been destroyed by dredge mining activities. Sedimentation caused by unstable banks and pollution from tailings are chronic problems that have reduced the stream's productivity.

Species: Spring chinook salmon, steelhead

Proposed Enhancement: A stream rehabilitation project is needed to restore biological productivity to the 5 miles of stream and increase it's anadromous fish production potentials. Fencing may be recommended and riparian plant species would be planted to stabilize the streambank and provide cover.

Data Needs: Detailed surveys are needed to measure acres of instream habitat that could be enhanced with the restoration project. Data to quantify expected increases to fish habitat and standing crops would be developed with fish population standing crop surveys and/or use of applicable data and information from similar stream.

Identified by: IDFG - Salmon

3.3.12 (t): Jordan Creek

Stream Location: This 6-mile long stream enters the Yankee Fork at RM 12.

Problem: Gold dredging in the 1940's degraded or destroyed about 3 miles (4 acres) of stream channel and riparian habitat near the mouth of the creek. The creek was forced to re-route itself through mine tailing piles and is no longer in it's natural channel. Part of the area is under a mining patent. There are numerous mining claims for the area.

Species: Chinook salmon, steelhead

Proposed Enhancement: Rework the stream channel to a more natural shape and plant adapted riparian plant species. Anadromous fish would have to be re-estabished in the area. Costs would be high.

Data Needs: Surveys would be made to obtain detailed estimates of the amount of new spawning and rearing areas that would be developed. Estimates of potential spawning adult use and juvenile production that could be realized from rehabilitating this area would be derived from current literature and data.

Identified by: USFS - Challis N.F.

Note: Mining patents and numerous mining claims would complicate enhancement activities.

3.3.12 (u): Valley Creek

Stream Location: This 21-mile long stream enters the Salmon River at RM 372.

Problem: Heavy livestock use in the lower 3 miles and between RM 6 and 11 has degraded streambanks and reduced riparian vegetation quantity and quality. This has resulted in a reduction of spawning and rearing capabilities of the stream.

Species: Spring chinook salmon, steelhead

Proposed Enhancement: A stream rehabilitation project is needed to restore biological productivity to 8 miles of stream and increase it's anadromous fish production potentials. Fencing may be recommended and riparian plant species might be planted to stabilize the bank and provide cover.

Data Needs: Detailed surveys are needed to measure acres of instream habitat that could be enhanced with a riparian restoration project. Data to quantify expected increases to fish habitat and standing crops would be developed with fish population standing crop surveys and/or use of applicable data and information from similar streams.

Identified by: IDFG - Salmon

3.3.12 (v): Alturas Lake Creek

Stream Location: This stream is 6 miles in length below Alturas Lake and enters the Salmon River at RM 390.

Problem: In addition to the flow augmentation needs (see Task 3.3.12.f), heavy livestock use has caused degradation of the stream habitat below the lake.

Species: Chinook salmon, steelhead

Proposed Enhancement: A stream rehabilitation project is needed to restore biological productivity to the 6 miles of stream and increase it's anadromous

fish production potentials. Fencing may be recommended and riparian plant species might be planted to stabilize the bank and provide cover.

Data Needs: Detailed surveys are needed to measure acres of instream habitat that could be enhanced with a riparian restoration project. Data to quantify expected increases to fish habitat and standing crops would be developed with fish population standing crop surveys and/or use of applicable data and information from similar stream.

Identified by: IDFG - Salmon

3.3.12 (w): Upper Salmon River

Stream Location: The upper Salmon River is considered to be that portion above RM 390 or the mouth of Alturas Lake Creek.

Problem: Heavy livestock use and irrigation diversions in areas along the Salmon River from the mouth of Alturas Lake Creek upstream 3 miles has reduced the quantity and quality of anadromous fish habitat.

Species: Chinook salmon, steelhead

Proposed Enhancement: A stream rehabilitation project is needed to restore biological productivity to the 3 miles of stream and increase it's anadromous fish production potentials. Fencing may be recommended and riparian plant species might be planted to stabilize the bank and provide cover.

Data Needs: Detailed surveys are needed to measure acres of instream habitat that could be enhanced with a riparian restoration project. Data to quantify expected increases to fish habitat and standing crops would be developed with fish population standing crop surveys and/or use of applicable data and information from similar streams.

Identified by: IDFG - Salmon

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the investigation and implementation, where appropriate, of the preceeding habitat projects in Idaho utilizing power revenues.

Task 3.3.13: Additional fishery habitat improvements
- Treaty tribes

Throughout the basin numerous other habitat problems have been noted by fishery agencies and Indian tribes. Due to time constraints placed upon the agencies and tribes to provide necessary recommendations by November 15, 1981, the following habitat improvements are recommended without substantial background discussions. It is recognized that additional comment will be forthcoming.

Task 3.3.14(a)

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program construction of fish screening facility at Stevens Ditch on the Naches River.

Task 3.3.13(b)

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program construction of fish passage at Stourmeir Dam on the Touchet River.

Task 3.3.13(c)

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program construction of fish passage at the Taneum Diversion Dam located on Taneum Creek, a tributary to the Yakima River.

Task 3.3.13(d)

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program evaluation of the adult fish passage facilities at Castille and Falls Five on the Klickitat River and provide funding for any needed modifications.

Task 3.3.13(e)

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program construction of the Dayton Reservoir in the Touchet River for instream flows in the Touchet and Lower Walla Walla River.

Task 3.3.13(f)

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program construction of fish passage at Three Mile Dam and improved screening at irrigation diversions on the Umatilla River.

Task 3.3.13(g)

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program investigation and necessary acquisition of unallotted water storage for instream flows throughout the basin.

Subobjective 3.4: Provide or restore passage to habitat unavailable to natural production of anadromous fish stocks affected by power development

Dams constructed prior to (or even after) the adoption of laws requiring the installation of fish passage facilities as part of the structure have, for many years, prevented the continued utilization of suitable anadromous fish-producing habitat by populations of those species. During the infancy of fish passage engineering, unsuccessful attempts to provide passage were made at various structures within the Columbia Basin.

Using current technology, fish passage can now be provided and presently unavailable habitat can be made useable.

Additionally, dams constructed for purposes other than power generation (irrigation diversion, flood control, etc.) as well as stream blockages caused by natural agents (log jams, falls, etc.) continue to prohibit or reduce the utilization of available habitat. Providing passage around these structures would allow for an increase in total production of anadromous fish.

Survival and passage success of juvenile anadromous salmonids at high head dams are affected by physical and chemical characteristics of the reservoirs, presence of predator and competitor fish, design of downstream migrant collection facilities, and the habits of juvenile salmon and steelhead. Korn, et al. (1967) found that juvenile salmon survived at a relatively high rate in a reservoir having few rough fish and predators and at low rates in reservoirs having these other fish. These general conclusions regarding survival of young salmon in reservoirs were confirmed by Ingram and Korn (1969), Smith and Korn (1970, and Wagner and Ingram (1973). These same studies and one by Korn and Smith (1971) showed that juvenile salmon grew well in all reservoirs and indicated that a large number of smolts could be produced in any reservoir where unwanted fish could be controlled and safe downstream migration of salmon smolts effected.

The above studies also showed that juvenile salmon and steelhead migrated near the reservoir surface in attempting to move downstream. This means that facilities built to collect smolts must provide a strong attraction flow relatively near the reservoir surface regardless of pool elevation. It was also shown that spring chinook juveniles migrate in numbers from fall through spring and therefore have the most flexible migration timing of the various anadromous species. Coho migrate mainly in May and June and to a lesser extent during winter freshets. Steelhead and sockeye salmon migrate during a narrow time period in April and May and their success depends upon having proper conditions for migration during this critical time period.

Fish passage was not provided at several of the high head dams built on Pacific Northwest streams in the early 1950's due to lack of knowledge regarding facilities needed to collect downstream migrants. Detroit Dam on the North Santiam River and Lookout Point Dam on the Middle Willamette in Oregon eliminated important salmon and steelhead production areas due to the lack of fish passage facilities.

One of the earliest successful downstream migrant collection facilities provided at a high head dam was built by Portland General Electric Company at North Fork Dam on the Clackamas River in 1957 (Gunsolus and Eicher 1970). This facility operates through a reservoir fluctuation of 19 feet and successfully collects spring chinook, coho, and steelhead smolts. However, passage problems persist at two older dams located downstream of North Fork (Oregon Department of Fish and Wildlife unpublished data).

The Washington Department of Fisheries developed a floating collector for juvenile migrants that succeeded in collecting smolts from reservoirs on the Baker River (Wayne 1960 and Quistorff, Mains, and Stockley 1968). A floating collector was also used with success at Merwin Reservoir in Washington, but heavy predation by squawfish resulted in failure of coho salmon production in that waterbody (Hamilton, Rothfus, Erho, and Remington 1970). At Round Butte Dam on the Deschutes River, the combined use of a floating collector and a collection facility built into the dam failed to collect migrants for passage downstream. The facilities failed because water currents in that impoundment

confused migrants so they would not congregate in one location for collection (Korn, et al., 1967). Passage of salmon and steelhead was more successful at Pelton Dam (Gunsolus and Eicher 1962) built prior to and downstream of Round Butte. The collection facility at Pelton fished through a 7-foot reservoir fluctuation. The failure of passage at Round Butte, however, eliminated salmon and steelhead production from upstream locations in the Deschutes and Metolius rivers.

At Cougar Dam on the South Fork McKenzie River, the U.S. Army Corps of Engineers (USACE) combined a downstream migrant collector with a water outlet control structure. This facility appeared to successfully collect juvenile spring chinook; however, most of the smolts collected were killed in passing through the facility (Ingram and Korn 1969). It was not determined how to safely pass smolts through the water outlet structure.

The USACE installed a unique downstream migrant collector at Green Peter Dam on the Middle Santiam River. This facility is built into the face of the dam, moves vertically on rails, and can collect smolts near the water surface regardless of the reservoir level. This collector successfully passed juvenile chinook and sockeye and to a lesser degree, steelhead (Wagner and Ingram 1973). Oregon Department of Fish and Wildlife biologists believe this type of facility could be used to rehabilitate anadromous fish runs at several projects not now having passage.

Fall Creek Dam, located on a tributary of the Willamette River is a non-power project built principally for flood control. Collection facilities built for juvenile salmon and steelhead failed (Smith and Korn 1970) due to construction of non-movable collectors at only three levels of the reservoir. During most of the migration season, the operating collector was unavoidably submerged at least 35 feet. Salmon and steelhead smolts generally would not sound to pass through these collectors. However, smolt passage has been provided by the USACE at this project through complete evacuation of the reservoir each fall. This has resulted in maintenance of the winter steelhead run at this project and greatly enhanced returns of adult spring chinook.

Complete reservoir evacuation as a means of providing smolt migration has potential for rehabilitating salmon populations at other non-power projects. Work conducted at Cottage Grove Reservoir on the Coast Fork Willamette River showed that spring chinook juveniles reared and survived well in the reservoir and emigrated successfully during complete evacuation (Lucas and Korn 1968 and Korn and Smith 1971). Initial adult returns caused Oregon Department of Fish and Wildlife researchers to question its success and this operation was terminated prematurely. Complete adult returns indicated good success, and we now believe a longer range test of spring chinook production at Cottage Grove is needed. Periodic chemical treatment of the reservoir would be needed to control rough fish and warmwater species, but this could be inexpensively accomplished in the fall after complete evacuation. Blue River Reservoir located on a stream of the same name, tributary to the McKenzie River, also has good potential for rearing juvenile spring chinook with migration effected through complete evacuation.

Several reservoirs in the Willamette Basin appear to have good potential for producing sockeye salmon. Lucas and Korn (1968) found juvenile sockeye reared well in Green Peter Reservoir, and that several impoundments in the Willamette system had environmental characteristics favorable for sockeye production. They also found that sockeye preferred to feed on copepods, while juvenile chinook, coho, and trout generally preferred other organisms. Sockeye also inhabitat deeper water than the other species. It is believed that sockeye can therefore be produced in reservoirs without seriously detracting from chinook and trout production.

Two broods of sockeye pre-smolts were released into Green Peter Reservoir, relatively small numbers were involved. Columbia River stock of the 1960 brood and Adams River (British Columbia) stock of the 1967 brood were planted. Totals of 352 (0.25 percent of release) Columbia River fish and 934 (0.38 percent of release) Adams River sockeye returned to the project as adults (Korn, 1972). Despite no further release of sockeye into the Willamette system, this species has perpetuated itself and gradually increased through the years. Counts of sockeye past Willamette Falls totalled about 3,000 adults in 1980 and 1,500 in 1981. The only known area of return has

been the Green Peter-Foster project on the South Santiam River. Also, in recent years most of the returning adults have been Columbia River stock.

By using several reservoirs in the Willamette system to produce sockeye and releasing much greater numbers of pre-smolts in each than were initially used at Green Peter, for several consecutive years, we believe harvestable populations could be developed. The Columbia River stock appears best suited for this purpose.

There are numerous impassible falls and logjams on tributaries to the Columbia River. A number of the stream areas above such obstacles have potential for producing juvenile salmon and steelhead. In some cases, resident trout will take priority and prevent the use of anadromous fish. In other cases, anadromous fish may be added to the resident population. In many instances, passage can be provided simply by construction of a fishway which would allow adults to ascend the obstacle or by removal of a logjam. Juvenile fish would spill over the falls.

Task 3.4.1: Establish a process which identifies and justifies specific passage improvement projects.

The upstream and downstream passage problems created by the Columbia and Snake River dams are primary factors affecting Columbia Basin anadromous fish runs.

Additionally, total barriers exist that are both manmade and natural that continue to block anadromous fish runs. In the past, problem areas have been identified and became part of multi-purpose projects such as fish passge at Enloe Dam as part of the Oroville-Tonasket Project. This approach has, however, been limited and the fisheries agencies and tribes ability and success at providing necessary passage at most problem areas has been minimal.

A thorough inventory of all river systems for passage restoration projects is required. The amount of available habitat for each species should be identified and potential production noted. Due to the depressed condition of upper river stocks, the process should begin in the upper Columbia River system and proceed downstream. A team composed of fishery biologists and passage experts should be established to accomplish the work in two years.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program establishment of a team to begin immediate inventory of all tributaries to the Columbia River to locate and document potential increases in salmon and steelhead habitat through restoration of passage. The inventory should be funded with power revenues.

Task 3.4.2(a): Similkameen River

Remove or ladder Enloe Dam, R.M. 8.8 on the Similkameen River. There exist over 100 miles of good spawning and rearing habitat for coho and chinook salmon and steelhead trout in the United States and Canada.

Two alternatives exist for passage. Removal at a cost of $525,000 with an annual benefit of $937,400 (after initial stocking), or laddering at a cost of $1.3 million with an annual benefit of $845,000 to the fisheries (expressed in 1977 dollars National Marine Fisheries Service). These costs and benefits are presently being updated.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the removal or laddering of Enloe Dam on the Similkameen River utilizing existing Bureau of Reclamation appropriations and/or power revenues if the present review continues to support the feasibility of this project.

Task 3.4.2(b): Big White Salmon River

Condit Dam, located at R.M. 3.3 on the Big White Salmon River, totally blocks passage of anadromous fish.

The production potential of the Big White Salmon River above Condit Dam is estimated at 3,200 summer steelhead, 2,700 fall chinook, and 200 coho salmon (White Salmon Division, Bureau of Reclamation, Columbia Northside Project). Passage should be provided past the dam, either by laddering or removed to provide fisheries benefits.

Recommendations: That the Power Planning Council provide programmatic support for the ongoing studies to determine improved anadromous fish production above and below Condit Dam and include in its Fish and Wildlife Program fish passage and improved instream flows should these and past studies indicate feasibility.

Task 3.4.2(c): Cle Elum River

Cle Elum Dam was constructed in the early 1930's by the Bureau of Reclamation, creating a reservoir with a storage capacity of 436,900 acre-feet. The dam has a hydraulic height of 124 feet. The dam currently has no fish passage facilities.

Construction of Cle Elum Dam eliminated sockeye salmon from the Cle Elum River by denying access to their spawning and rearing habitat. In addition, many miles of spring chinook and steelhead spawning and rearing habitat were also lost.

To re-establish utilization of the potential natural production habitat in the Cle Elum River system above Cle Elum Dam, juvenile and adult fish passage facilities are required at the dam. A study should be initiated to determine the feasibility of re-establishing sockeye and other anadromous fish runs above the dam.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program an investigation of the feasibility of restoring anadromous fish runs above Cle Elum Dam and provide passage if studies should indicate feasibility, utilizing power revenues.

Task 3.4.2(d): Box Canyon and Entiat Falls Fish Ladders
- Entiat River

Objective: To develop anadromous fish passage around existing barriers. To provide access to additional spawning areas.

Project Description: Two development sites for fish passage occur beyond Fox Creek, 27.7 miles up the Entiat River.

Present Situation: Interstitial spaces of gravels in the lower reaches of Entiat River and denuding of streamside vegetation by recent conflagrations provide poor spawning and rearing conditions. The Entiat River above Fox Creek has pristine conditions available for anadromous fish.

Project Proposal: Prepare plans for two fish passage facilities. Construct facilities with power revenue funding.

Project Benefits: Approximately 10 miles of additional spawning areas will be made available to steelhead trout and spring chinook salmon runs. These developments will provide at least 400 recreation visitor days initially to the sport fishery of Washington and 6,000 pounds of chinook salmon to the commercial and Indian fisheries. A more detailed economic analysis will be made during project planning.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program a study to determine the feasibility of increasing salmon and steelhead habitat in the Entiat River by providing fish passage at two barriers and construction of the ladders by the U.S. Forest Service utilizing power revenues depending on the results of the studies.

Task 3.4.2 (e): Cougar Dam - South Fork McKenzie River

Fish passage failed at Cougar Dam due to high mortality of salmon smolts caused by combining the downstream migrant collector with the water outlet structure. However, the reservoir is free of undesirable fish, and along with the river above, is capable of rearing a large number of salmon smolts. Natural producton of trout is relatively poor in Cougar Reservoir and the South Fork McKenzie. The area is better suited to production of salmon smolts. ODFW biologists believe safe and efficient smolt passage could be provided at Cougar by constructing a Green Peter type collector. Spring chinook and sockeye smolts could be produced in the reservoir and chinook smolts in the river upstream. Other than Detroit, which is presently reserved for management of resident trout, the are above Cougar Dam has the highest potential for successful rehabilitation of salmon. This potential can be achieved by installation of an adequate downstream-migrant collector.

(a) Construction

Install Green Peter type collector to provide downstream migrant passage. Include pipeline to deposit juvenile fish in tailrace of dam and trap for evaluation. Construct new adult collection facilities in Cougar Dam (collection water for adults must be warmer than that discharged through turbines). Purchase truck for adult hauling.

Cost of collector and pipeline: $5.0 - $7.0 million
Cost of tank truck: $100,000

(b) Operations

Funds needed to operate juvenile and adult collection facilities, for a truck to haul adults to spawning areas, and for an 8-year evaluation study to determine success.

Cost to operate collection facilities: $9,000
Cost of evaluation: $85,000
Cost to operate tank truck: $4,000

(c) Estimated benefits (annual)

Spring chinook - 4,500 adults return to project plus
13,500 adults contribute to fishery.
Estimated value: $2,100,000

Sockeye - 5,000 adults return to project
Value estimate pending.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of juvenile passage and adult collection facilities at Cougar Dam by the Corps of Engineers.

Task 3.4.2(f): Blue River Dam - Willamette River System

Blue River Dam is a flood control project that does not produce power. It was not provided with fish passage facilities. Blue River contained a small run of spring chinook prior to construction of the dam and these were compensated by a hatchery. Blue River Reservoir does not harbor large populations of rough fish. While it is suitable for salmonid production, it is more suited for rearing salmon smolts than it is large trout. Complete evacuation of the reservor each fall would provide a successful and inexpensive means of allowing emigration of salmon smolts.

A. Construction

Build adult collection facility and purchase truck for hauling.

Cost of adult collection facility:

Cost of tank truck: $100,000

B. Operation

Evacuate reservoir each fall to effect migration of juveniles.
Operate truck to haul adults. Fund 8-year evaluation study.
Cost of complete drawdown (addtional to normal drawdown): None
Cost to operate truck: $2,500

C. Estimated Benefits (annual)

Spring chinook - 2,500 adults return to project plus
7,500 adults contribute to fishery.
Estimated value: $1,167,000

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of adult collection facilities and

operation of Blue River Dam to allow reservoir rearing of spring chinook salmon.

Task 3.4.2(g): Collowash Falls - Collowash River, Willamette River System

Collowash Falls is a nearly impassible barrier located at R.M. 7.5 on the Collowash River. Collins (1973) determined that there is 8.4 miles of excellent spawning and rearing area that could be made available to anadromous fish by constructing a fishway at the falls. Collins also estimated the numbers of salmon and steelhead that could utilize the spawning area. He stated that the spawners would produce more young fish than could rear in the Collowash, but they would aid in seeding the extensive rearing area in the Clackamas River downstream. The economic data in Collins' report are updated below.

A. Construction

Construct fishway over Collowash Falls to allow anadromous fish access to 8.4 miles of fish production area in the upper Collowash River.

Cost of fishway:

B. Operation

Annual fishway maintenance.

Cost of maintenance:

C. Estimated Benefits (annual)

Spring chinook -	3,000 adult return
Coho salmon -	1,000 adult return
Steelhead -	2,000 adult return
Estimated annual value:	$1,285,000 (value reduced by 40 percent due to potential losses at PGE dams downstream)

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the laddering of Collowash Falls.

Task 3.4.2(h): Falls - Little Fall Creek - Willamette River System

A. Construction

Construct formal fishway 180 feet long over two falls, having a 24-foot rise on Little Fall Creek to provide anadromous fish access to 6 miles of fish production area.

Cost of fishway: $106,300

B. Operation

Annual fishway maintenance.
Cost of maintenance:

C. Estimated Benefits

Steelhead	-	400 spawners
Spring chinook	-	100 spawners
Estimated annual value:		$96,000

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of a fishway on Little Fall Creek utilizing power revenues.

Task 3.4.2(i): Falls - South Fork Klaskanine River

A. Construction

Construct fishway over 20-foot high falls on South Fork Klaskanine River to allow anadromous fish access to 10-12 miles of fish production area.

Cost of fishway: $14,000 (blasting pools - not a formal fishway).

B. Operation

Annual fishway maintenance.

Cost of maintenance:

C. Estimated Benefits

Coho salmon	-	250 spawners
Steelhead	-	200 spawners
Searun cutthroat	-	200 spawners

Estimated annual value of coho and steelhead: $75,000

No value available for cutthroat

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the development of a fishway over falls on the Lewis and Clark River, utilizing power revenues.

Task 3.4.3: Fish Passage Barrier Removal - Idaho

Several Idaho streams have barriers to salmon and steelhead passage which if removed would provide significant amounts of additional spawning and rearing habitat. The resulting increased production would help attain Columbia Basin fish production goals by providing a means of compensation for unavoidable passage losses.

Task 3.4.3(a): Meadow Creek

Stream Location: Meadow Creek is 15 miles long and enters the south Fork Clearwater River at R.M. 33.

Problem: A natural rock falls located about 300 yards up from the mouth is a partial barrier to upstream fish migration. This causes a significant reduction in the anadromous fish production potential. Idaho Department of Fish and Game considers this area to be important steelhead habitat.

Species: Steelhead trout.

Proposed Enhancement: Stair-step blasting of the falls area would enhance upstream anadromous fish passage.

Identified by: Idaho Department of Fish and Game, U.S. Forest Service - Nez Perce National Forest.

Task 3.4.3(b): Crooked River

Stream Location: Crooked River is 17 miles long and enters the South Fork of the Clearwater River at stream mile 58.4.

Problem: At milepost 8.2 on Crooked River road No. 233, a culvert blocks upstream fish passage. As a result, full utilization of upstream spawning areas is not occurring. There are also old dredge mining sites, one near the

mouth and one approximately 10 miles upstream, that have destroyed riparian habitat.

Species: Spring chinook salmon.

Proposed Enhancement: Replacement of the existing culvert with a bottomless arch type culvert would provide access to 18 acres of spawning and rearing habitat. The estimated cost to replace the culvert is $24,000. Leveling the dredge tailings and selectively planting appropriate shrubs in the mined areas would help restore riparian zones in these areas.

Data Needs: Surveys are needed to obtain detailed estimates of the amount of new spawning and rearing areas that would be developed. Estimates of potential spawning, adult use, and juvenile production that could result from opening up this area would be derived from current literature and data.

Identified by: U.S. Forest Service - Nez Perce National Forest

Task 3.4.3(c): Crooked Fork Lochsa River

Stream Location: This stream converges with Sand Creek and Walton Creek to form the Lochsa River at R.M. 70.1.

Problem: A natural rock barrier at R.M. 15.3 is a partial barrier to upstream fish passage. As a result, full utilization of upstream spawning areas is not occurring.

Species: This is a major production area for spring chinook salmon in the Lochsa River system.

Proposed Enhancement: Removal of the barrier with explosives would facilitate upstream fish passage to 6 more miles of spawning and rearing habitat. Estimated cost of the barrier removal is $15,000.

Data Needs: Surveys are needed to obtain estimates of the amount of new spawning and rearing areas that would be opened up. Estimates of potential

spawning, adult use, and juvenile production that could result would be derived from current literature and data.

Identified by: U.S. Forest Service - Clearwater National Forest

Task 3.4.3(d): Colt Creek

Stream Location: This creek enters White Sand Creek at approximately R.M. 13.5. White Sand Creek converges with the Crooked Fork to form the Lochsa River at R.M. 69.5.

Problem: Approximately 2½ miles from the confluence with White Sand Creek a debris barrier impedes upstream fish passage.

Species: Steelhead.

Proposed Enhancement: Removal of this barrier would create access to approximately 6 miles of spawning and rearing habitat. Estimated cost of barrier removal is $15,000.

Data Needs: Surveys are needed to obtain detailed estimates of the amount of new spawning and rearing areas that would be opened up. Estimates of potential spawning, adult use, and juvenile production that could result would be derived from current literature and data.

Identified by: U.S. Forest Service - Clearwater National Forest.

Task 3.4.3(e): Eldorado Creek

Site Description: Eldorado Creek enters Lolo Creek at R.M. 25.5. Lolo Creek enters the mainstem Clearwater River at R.M. 54.1.

Problem: Approximately 1 mile from the confluence with Lolo Creek, a series of natural basalt falls create a barrier to upstream fish passage.

Species: Spring chinook salmon, steelhead.

Proposed Enhancement: Passage through this area can be enhanced by blasting out barriers and creating some stair-step pools at the lowermost falls. This would open up approximately 10 miles of spawning and rearing habitat.

Data Needs: Surveys are needed to obtain detailed estimates of the amount of new spawning and rearing areas that would be opened up. Estimates of potential spawning, adult use, and juvenile production that could result would be derived from current literature and data.

Identified by: U.S. Forest Service - Clearwater National Forest

Task 3.4.3(f): Badger Creek

Stream Location: Badger Creek enters the upper Lochsa River at R.M. 61.9

Problem: A culvert, under Highway 12, at the mouth of the creek is a complete barrier to upstream fish passage.

Species: Steelhead

Proposed Enhancement: Replacement of culvert with a bottomless arch type culvert would facilitate upstream passage to approximately 2 miles of spawning and rearing habitat. Estimated cost of culvert replacement is $125,000.

Data Needs: Surveys would be made to obtain detailed estimates of the amount of new spawning and rearing areas that would be opened up. Estimates of potential spawning, adult use, and juvenile production that could result would be derived from current literature and data.

Identified by: U.S. Forest Service - Clearwater National Forest.

Task 3.4.3(g): Wendover Creek

Stream Location: Wendover Creek enters the upper Lochsa River at R.M. 64.2

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program resolution of the described fish barriers in Idaho, utilizing power revenues, to increase salmon and steelhead production

Problem: A culvert under Highway 12 is a partial block to upstream fish passage.

Species: Steelhead

Proposed Enhancement: Replacement of culvert with a bottomless arch type would facilitate upstream passage to an additional 2 miles of spawning and rearing habitat. Estimated cost of culvert replacement is $125,000.

Data Needs: Surveys would be made to obtain detailed estimates of the amount of new spawning and rearing areas that would be opened up. Estimates of potential spawning, adult use, and juvenile production that could result would be derived from current literature and data.

Identified by: U.S. Forest Service - Clearwater National Forest.

Task 3.4.3(h): Boulder Creek

Stream Location: This 16-mile stream enters the Little Salmon River at R.M. 16.

Problem: A 10 to 12-foot rock falls partially blocks upstream fish passage about 4 miles from the mouth of the stream. The falls is probably not a block to steelhead, although it blocks nearly all chinook salmon passage.

Species: Spring chinook salmon, steelhead.

Proposed Enhancement: Eliminate passage block with explosives to open up about 10 to 12 miles of spawning/rearing habitat.

Data Needs: Surveys are needed to obtain detailed estimates of the amount of new spawning and rearing areas that would be opened up. Estimates of

potential spawning adult use and juvenile production that could result would be derived from current literature and data.

Identified by: U.S. Forest Service - Payette National Forest.

Task 3.4.3(i): Cabin Creek Culvert Replacement

Objective: Replace three culverts that are blocking upstream migrating summer chinook salmon.

Beginning Date: July 1983 - engineering and drafting
July 1984 - construction

Completion Date: October 1985

Cost: $140,000

Benefit: Replacement of three culverts with a bridge will access 12 miles of stream with an estimated 10,000 yards of spawning gravel and 120,000 square years of rearing area. Additional spawning and rearing space will increase smolt capability of 40,000 smolts to the ocean.

Task 3.4.3(j): South Fork Salmon River Stream Improvement

Objective: Remove logs and debris from tributaries that are preventing upstream migration of adult summer chinook.

Beginning Date: July 1983.

Completion Date: July 1984.

Cost: $20,000

Benefit: Stream clearance will open up 15 stream miles with an estimated 20,000 square yards of spawning gravel and 150,000 square yards of rearing

area. Additional spawning and rearing space will increase smolt capability by 45,000 smolts to the ocean.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the investigation and implementation, where appropriate, of the preceeding passage improvement projects in Idaho utilizing power revenues.

CHAPTER 4

OBJECTIVE IV:

Artificial Production

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OBJECTIVE IV: ARTIFICIAL PRODUCTION

Introduction: The potential for use of artificial production facilities (hatcheries) for improvement of fish production or in the replacement of fishery resources lost through various influences has long been recognized. The first fish hatchery in North America was established in 1864 by Seth Green at Mumford, N.Y. By 1872, the first Pacific Coast fish culture station had been established on the McCloud River in California (1). Hatchery production of salmonid species on the entire Pacific Coast has continued to grow until, in 1976, the release of anadromous fish of all species totalled 294 million fish weighing 11.1 million lb. (Ibid). With major public and private projects underway continually, the number has surely been exceeded with the coming of the 1980's.

Early recognition of decreasing salmon production and the opportunity to compensate for these losses through hatchery production was demonstrated by Washington State Fish Commissioner, James Crawford in his first report to the Governor of Washington (in 1890). He said "To foster and replenish the streams of our state with salmon and trout, the establishment of a hatchery is a positive necessity" (Ibid). Since that time, the role of hatcheries in replacing losses due to a variety of causes has continued to grow.

The initial major recognition of federal responsibility for losses of the fishery resource resulting from habitat degradation and water use project construction in the Columbia River was demonstrated by the Mitchell Act of 1938 as amended August, 1946. The act called for construction of "...one or more salmon-cultural stations in the Columbia River Basin in each of the States of Oregon, Washington, and Idaho." Initially, 21 hatcheries were constructed or remodeled with funds appropriated through this act. By 1980, 22 hatcheries were funded in whole or part, by the Columbia River Fisheries Development Program established under the Mitchell Act. The total expenditures through 1980 have exceeded $113,269,000 (2).

As the demand for hydroelectric generating capacity increased and more projects were built, more of the anadromous salmonid resource was affected through loss of spawning habitat, adult and juvenile passage problems, shifts in mainstem and tributary flow conditions, and water quality degradation. Along with these effects came the awareness of the need for compensatory actions to accompany the construction of hydro-projects. In recent times, artificial production facilities have been an integral part of most licensing procedures associated with hydro-project construction and hatcheries have sprung up throughout the Columbia Basin to replace salmonid resources lost to hydropower projects. Many of the Basin hatcheries were constructed at least in part as mitigation for both federal and private utility projects and their releases constitute the majority of the hatchery production emanating from the Columbia River system.

The Lower Snake River Fish and Wildlife Compensation Plan (LSRCP) authorized by the Water Resources Development Act of 1976, P.L. 94-587, is the most recent example of a major hatchery construction program provided as mitigation for salmonid losses associated with hydropower projects. This package is designed to mitigate for losses resulting from the four lower Corps of Engineers facilities on the Snake River; Ice Harbor, Lower Monumental, Little Goose, and Lower Granite. The LSCRP is unique in that the mitigation requirement addresses not only the salmonid losses due to the lost habitat, but primarily the additional losses specific to operation of the four facilities and resulting from adult and juvenile passage problems (3).

The Pacific Northwest Electric Power Planning and Conservation Act, P.L. 96-501, recognizes and encourages the use of artificial production facilities in its aim to correct heretofore uncompensated losses resulting from hydropower development and operation or in the development of new facilities. It is stated in the Act that "Enhancement measures shall be included in the program to the extent such measures are designed to achieve improved protection and mitigation," 4(h)(5). The act further instructs that "Enhancement measures may be used, in appropriate circumstances, as a means of achieving offsite protection and mitigation," 4(h)(8)(A). In order that the agencies involved might secure due compensation and protection, the Act instructs the Power Planning Council to "Adopt a program to protect,

mitigate, and enhance fish...on the Columbia and tributaries," 4(h)(1)(A). To secure this program the act "directs the Council to request from the agencies recommendations for fish and wildlife management coordination and research and development (including funding) which, among other things will assist...enhancement of anadromous fish...." 4(h)(2)(C) (Emphasis added).

The Role of Artificial Production

The potential of artificial production facilities to successfully produce salmonid species has been proven. For example, releases of coho salmon over a two-year period from 20 Mitchell Act hatcheries produced an estimated 2.1 million coho at an average benefit/cost ratio of 7.0:1. A similar four-year study of fall chinook from 13 hatcheries showed a contribution of 1.5 million chinook with a benefit/cost ratio of 4.2:1 (2). In geographical areas where survival rates are higher than those from the Columbia River system, benefit/cost ratios have exceeded 18:1 (Washington Department of Fisheries, unpublished analysis).

In its basic context, the role of hatchery facilities in protection, mitigation, and enhancement is two-fold. First is to attempt to restore total production to historical levels. The 4(h) Program under the Power Act will provide for restoration of losses, to the extent possible, through improved juvenile and adult passage and enhanced use of natural production capacity (Objectives I through III). It is recognized that, even with major improvements in passage and flow, a deficit will exist between pre-dam production levels and present day levels due to passage problems associated with power dam operations. This deficit is well demonstrated by Junge (4). Based on mortality estimates on juvenile and adult migrants, Junge estimates that with all modernization of passage facilities a 15 percent deficit may still exist. Whatever the loss may be, it must be made up through habitat improvement and artificial production. Subobjectives 4.1, 4.2, and 4.4 address the role of hatcheries in providing increased production.

The second application of artificial production facilities will be to facilitate distribution of production potential to meet harvest management requirements, fishery distribution requirements, and species-specific

escapement objectives. Distribution requirements can be met by adept location of major production facilities, off-station planting locations, satellite facilities, off-site release ponds, etc. This segment of compensation is addressed in Subobjectives 4.3, 4.5, and 4.6.

The following Objective IV task recommendations will present a program for applying artificial production capabilities to the problem of compensation and mitigation under the Power Act. The discussion will include recommendations for siting and construction of new hatcheries to increase overall production (4.1 and 4.2). Recommendations will also be made to improve efficiency within existing hatchery facilities and for improved quality of salmonids now produced (4.4). Recommendations will be made to ensure that salmonids produced for compensation, will be released at locations and in numbers compatible with natural production and harvest management considerations, and treaty obligations (4.3). Provisions will be recommended to take advantage of low-capital, small-scale production facilities that will further improve capability to distribute production (4.5). Finally, the feasibility of using hatchery outplants to supplement natural production will be investigated (4.6).

Limitations

The use of hatchery production must be viewed with an eye to practical limitations. Some of these will be addressed briefly herein.

1. Over the past ten years it has become apparent that salmonid production cannot be increased indefinitely without limit from major systems like the Columbia River. While hatchery releases of coho salmon have increased phenomenally, adult production from these releases has dropped drastically in the area of the Oregon Production Index. Several possible explanations have been advanced and the cause of the phenomenon is not resolved. One hypothesis implies a density-dependent relationship possibly coupled with or exaggerated by unfavorable environmental conditions. A thorough discussion of this problem can be found in a "Comprehensive Plan for Production and Management of Oregon's Anadromous Salmon and Trout; Part II. Coho Salmon Plan" (5).

2. Species Interaction Problems. Ames (6) has proposed specific inter-species interaction problems associated with enhancement of some Puget Sound coho stocks. This class of problem may also manifest itself in Columbia River fall chinook performance (D. Austin, pers. comm.).

3. Stock Selection Problems. Geneticists (and others) have expressed discomfort with stock selection processes used in hatchery facilities. Most apparent of these is inadvertant selection for earlier run timing. The most threatening; however, might be indiscriminate transfer of brood stock resulting in loss of genetic variability and likely loss of overall performance.

4. Mixed Stock Fishery Problems. These problems have developed in the past and and have manifested themselves in depression of wild stock escapement. More recently, mixed stock fisheries have become a legal problem in meeting allocation requirements. The use of hatcheries must address distribution needs.

Each of the potential problems noted need not become actual problems if the application of artificial production capability is the result of a well thought strategy. The potential for such a strategy exists within the 4(h) provisions of the Power Act.

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Subobjective 4.1: Determine feasible locations for increased artificial production to compensate for losses resulting from hydroelectric development on Columbia Basin anadromous fish stocks, compatible with mitigation efforts, natural production and harvest considerations.

Artificial production will play a major role in improving anadromous fish runs in the Columbia Basin. Junge (unpub. m.s., 1981) (1) estimates that, of the shortfall of production resulting from hydropower-related losses, as much as 15 percent will have to be regained through mitigation and compensation at artificial production facilities and through habitat improvement projects. The task descriptions contained in this subobjective will set out processes by which suitable sites for artificial production will be identified and chosen through a priority selection system.

Since successful production of salmonids hinges on the water supply, water availability may be the critical limiting factor for the future increase in artificial production. Task 4.1.1 will establish an investigation process to identify and compile all available information on potential hatchery water sources within the Columbia Basin. In addition, exploration will be recommended to uncover any new sources of water not previously identified. Water resource information will be presented in a resource compendium for use by all participating agencies.

There is some potential for expansion of water supplies and increased production at existing facilities. Task 4.1.2 represents results of a survey of existing hatcheries. Increased rearing potential is identified at 17 of those hatcheries. Potential for micro-hydropower facilities is identified for 5 - 7 hatcheries.

Hatchery siting and construction is also determined in part by consideration of the species involved, release sites available, production levels required, and harvest management priorities.

Task 4.1.3 will set up a process by which proposed artificial production sites can be evaluated and prioritized in terms of priority needs of the major Columbia River Basin compensation plan as well as the biological requirements of the cultured species.

Under the 4(h) provisions of the Power Act, each of these task developments will require that funding proposals be submitted to Bonneville Power Administration and that Bonneville Power Administration provide adequate funds to accomplish the desired objectives.

LITERATURE CITED

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Task 4.1.1: Locate and Quantify New Hatchery Water Supplies

Introduction: Selection of the hatchery site is the single-most important decision of all those involved in development of a production facility. Successful hatchery production programs are based primarily on availability of adequate water of high quality.

In historical terms, site selection often involved the most readily available and accessible water supply. As would be expected, the most desirable locations were those occupied early on and good hatchery sites have become increasingly rate. Site selection has also increased in complexity as fishery management, catch distribution, and cost factors receive more attention. This fact has become readily apparent in results of recent site selection efforts associated with the Lower Snake River Fish and Wildlife Compensation Plan (LSRCP).

It is imperative that efforts in hatchery site identification and selection be emphasized and a comprehensive compendium of the sites with development potential be compiled. This effort is required to initiate Phase I compensation for unavoidable losses due to power development.

Status: Site selection activities have been initiated sporadically by most agencies engaged in anadromous fish production. Generally, these undertakings are related to a specific funding source or project. The most outstanding recent examples are efforts related to the LSRCP (1) and the Mid-Columbia River Study (2). Other Projects or development programs have also contributed in some measure, to the current store of information (bibliography).

Available documents are attached (Appendix). Several documents secured for this presentation include sites that were subsequently develodped. This is not a comprehensive review, rather it serves as an example of the current level of information availability. It should be noted that no comprehensive compendium of sites exist in any state or federal agency. Information from Washington State is piecemeal with various bits of work done under several

project applications. Idaho has no in-state documentation although several Idaho sites were included in the various LSRCP reports. Oregon developed a memorandum (Appendix) relating to the LSRCP but has no in-state site catalog. National Marine Fisheries Service compiled input from state agencies in a document dated 1979 (Appendix) but maintains no comprehensive catalog. Also of note is the difficulty in securing information on the work done subsequent to identification of a proposed site. In many cases, only agency historians were able to describe the turn of events leading to analysis and rejection of a given site. In other cases, documentation in the form of feasibility studies, pumping test reports, etc., exist but tracking these bits and pieces of information will be a painstaking and time-consuming task.

Needed Research: It is clear, both from the level of documentation available and from personal communication, that information exists in many forms throughout the interested agencies. It is also clear that many sites are identified repreatedly under different auspices and evaluation effort is duplicated and then fades from the record. As a consequence of this investigation, a study with the following objectives must be undertaken:

A. Develop a comprehensive compendium of existing site data for the Columbia River Basin.

B. Establish a program for identification and exploration of new hatchery sites in the Columbia River Basin. Characterize these sites as to certain criteria established under Task 4.1.3. Add these site data to the above compendium.

Anticipated Results: Completion of the study would result in a single concise document to which all agencies could refer when development opportunities are presented. The project would also establish a routine by which information could be submitted and updated on a continuing basis. The compendium would also serve to prevent costly duplication or replication of effort, serving as the authoritative source document for all users.

Scope of Work: The general approach to accomplish objectives A and B is through a contracting procedure similar to those successfully used by the

mid-Columbia public utility districts (2). The two objectives could be carried out concurrently or sequentially, depending on time requirements and budget availability. Objective B would require appreciably more time (and, in fact, should be a continuing process).

Contract bidding and procurement would be by Bonneville Power Administration. Oversight responsibilities could be assigned to any of several alternative participants:

1. Columbia River Fisheries Council (APC)
2. Ad-Hoc Executive Committee
3. Single agency representative

A procedural outline for a sequential approach follows:

A. Power Planning Council sanctions objectives.

B. Power Planning Council obligates funds for planting.

C. Ad-Hoc Executive Committee (AHEC) assigns responsibility for planning project description to:

   1. APC
   2. AHEC special appointee
   3. Single agency representative

D. AHEC receive and provide project description to BPA for bidding.

E. Bonneville Power Administration solicits bids for objective A.

F. Bonneville Power Administration acquires bid and assigns project responsibility to AHEC.

G. AHEC assigns oversight responsibility for contract to:

   1. APC

2. AHEC appointee
3. Single agency representative

H. Contractor performs tasks and provides document to AHEC, Bonneville Power Administration, and oversight assignee.

I. Repeat process A through H for objective B.

Alternative 1. Objectives A and B planned and bid by process described above as two sequential projects or contracts.

Alternative 2. Objectives A and B planned and bid as separate concurrent projects.

Alternative 3. Objectives A and B planned and bid in a single project following steps A through H in a single pass-through.

Recommendation: That the Power Planning Council adopt in its Fish and Wildlife Program research to develop a basin-wide compendium of existing hatchery site data and to identify and conduct exploration for new hatchery sites.

Waikiki Springs Hatchery

The Waikiki Springs hatchery site is suitable for propagation of up to 500,000 steelhead smolts annually.

Introduction: The Washington Department of Game (WDG) proposes development of a steelhead hatchery at Waikiki Springs in Spokane.

Status: The hatchery site has 20 cfs of spring water available; however, water rights have not been secured because the water supply has not been demonstrated.

Anticipated Results: Funding would provide a feasibility study of the site, leading to securing of water rights and a request for design and construction funding.

Scope of Work:

A. WDG provides formal funding request to Power Planning Council.

    1. Site characteristics

    2. Legal status

    3. Probability statement for feasibility

B. Power Planning Council's program provides funds for feasibility study of Waikiki Springs site.

C. WDG conduct feasibility study and report to Power Planning Council.

    1. In-house

    2. By consulting contract

Recommendations: WDG recommends that a proposal be presented for funding of feasibility studies of this site and that funds be provided under the Fish and Wildlife Program of the Power Planning Council.

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Toutle Salmon Hatchery. Columbia River Fisheries Development Program Capital Project Feasibility Study. Sverdrup and Parcel and Assoc., Inc. for State of Washington, Department of Fisheries, Olympia, WA. February, 1977.

Appendix

WASHINGTON
Department of
FISHERIES

DANIEL J. EVANS
GOVERNOR

ROOM 115 GENERAL ADMINISTRATION BUILDING • PHONE 753-6600
OLYMPIA, WASHINGTON 98504

THOR C. TOLLEFSON
DIRECTOR

APPENDIX A

November 7, 1974

Colonel Nelson P. Conover, District Engineer
Walla Walla District
U.S. Army Corps of Engineers
Building 602, City-County Airport
Walla Walla, WA 99362

Dear Colonel Conover:

We are pleased to submit for your examination the tabular summary for hatchery requirements and rearing programs for the Lower Snake River Compensation Plan. This report was prepared by the Columbia Basin Fisheries Technical Committee's Lower Snake Hatchery Subcommittee. It has been approved by both the Columbia Basin Fisheries Technical Committee and the respective directors.

Tables 1 and 2, which were prepared several months ago, have a slight discrepancy in the adult chinook requirements (18,512 instead of 18,300). Except for variations due to rounding, we believe the values in the other tables are conservative. Table 3 summarizes the overall program criteria, while Table 4 lists the pounds of smolts to be released for each release site. Table 5 lists a general physical description of available water supplies for each hatchery.

Two tables have also been prepared for each of eight proposed hatcheries: the "A" tables giving the rearing criteria, and the "B" tables giving the specific information relative to hatchery requirements.

We suggest that you and members of your staff examine these closely prior to our meeting with you on November 15. Mr. Robert Hager, Hatchery Subcommittee chairman, will be prepared to answer any questions you may have at the meeting.

Various field tests, i.e., average ground water sources, etc., will be required. We feel this work should be conducted by the Corps and that site investigation should proceed immediately. The fishery agencies will be prepared at the November 15 meeting to supply names of agency representatives that will act liaison with your staff in this endeavor.

Sincerely,

Thor C. Tollefson

Thor C. Tollefson
Director

Enclosures

cc: Gene Kruse - Fish Commission of Oregon
John McKean - Oregon Wildlife Commission
Joseph Greenley - Idaho Fish & Game
Carl Crouse - Wash. Dept. of Game
Kahler Martinson - U.S. Fish & Wildlife Service
Don Johnson - National Marine Fisheries Service
Columbia Basin Fisheries Technical Committee
Robert Hager - Wash. Dept. of Fisheries

Table 1. Distribution of Salmon and Steelhead Requiring Hatchery Compensation. (Obtained by taking 48% of values presented in table on page 10 of Lower Snake River Report)

Area	Fall Chinook 1/	Spr. or Summer Chinook	Steel-head
Snake River			
Below Lewiston	5,000		
Lewiston-China G.	3,580		2,208
China G.-High Mtn. Sheep	743		
High Mtn. Sheep-Appaloosa	203		
Appaloosa-Pleasant Valley	743		
Pleasant Valley-Hells Canyon	4,459		
Hells Canyon Dam Fish Facilities	3,648	1,200	2,736
Tucannon River		1,152	1,632
Clearwater River	68	288	20,736
Asotin Creek			816
Grande Ronde River		5,856	7,632
Salmon River		46,656	16,896
Imnaha River	68	3,216	1,920
Small tributaries		288	528
Total	18,512	58,656	55,104

1/ *Total compensation for fall chinook has been adjusted to agree with Corps' report, but distribution agrees with original report. These are to be produced by Washington Department of Fisheries.*

Table 2. Allocation of Compensation (Adults) by State as Suggested by CBFTC, November 2, 1973. Not to be used as an indicator of specific release sites.

Area	Washington			Oregon		Idaho	
	Spring Chinook	Fall Chinook	Steelhead	Spring Chinook	Steelhead	Spr. & Sum. Chinook	Steelhead
Snake River							
Below Lewiston		5,000					
Lewiston-Hells Canyon		9,728	2,208				
Hells Canyon Dam		3,648			1,368 1/	1,200	1,368 1/
Tucannon River	1,152		1,632				
Clearwater River		68				288	20,736
Asotin Creek			816				
Grande Ronde River				5,856	7,632		
Salmon River						46,656	16,896
Imnaha River		68		3,216	1,920		
Small tributaries					264 1/	288	264 1/
Total	1,152	18,512	4,656	9,072	11,184	48,132	39,264

1/ *Young of these fish not to be released in Snake River because of conflict with IPC compensation program. Release sites to be determined by states of Idaho and Oregon.*

Table 3. Hatchery Requirements to Produce Required Numbers of Adult Chinook and Steelhead 1/

	Fall Chinook	Spr. & Sum. Chinook	Summer Steelhead
Number of Females	2,29[illegible]	2,140	3,3[illegible]
Eggs per Female	5,00[illegible]	4,50[illegible]	5,000
Number of Eggs	11,450,00[illegible]	9,631,600	16,957,[illegible]
Survival (eggs to smolts) Percentage	8[illegible]	7[illegible]	65
Number of Smolts	9,160,00[illegible]	6,741,500	11,021,000
Fish per Pound	[illegible]90	15	8
Pounds of Smolts 2/	101,80[illegible]	449,440	1,377,600
Survival (smolt to adult) 3/ Percentage	0.2[illegible]	0.87	0.50
Number of Returning Adults (mitigation)	18,30[illegible]	58,700	55,100

1/ *Totals of individual hatcheries cause obvious rounding errors in values.*

2/ *Pounds of smolts reared is the most significant item both with respect to hatchery costs and eventual adult production. Size and numbers may be adjusted to hatchery practice.*

3/ *Survival to Lower Granite Dam.*

Table 4. Hatchery Production and Area of Release

Station	Thousands of Pounds of Reared Fish						General Area of Release
	SH	Catchable Trout	Fall Chin.	Spr. Chin.	Sum. Chin.	Total	
Pasco			101.8			101.8	Hatchery
				8.8		8.8	Tucannon
Total						110.6	
Rocky Ford	116.4					116.4	S.E. WA rivers
		93.0				93.0	Undetermined
Total						209.4	
Lostine	225.0			44.9		269.9	Hatchery
Imnaha	54.6			24.6		79.2	Hatchery
Powell	125.0					125.0	White Sand Cr. (Upper Lochsa)
	100.0					100.0	Potlatch Cr. (Clearwater)
					99.6	99.6	Upper Lochsa
	125.0				61.3	186.3	Crooked River (S.F. Clearwater)
Total	350.0				160.9	510.9	
Briggs Springs	50.0					50.0	Rapid River
	100.0					100.0	Johnson Creek
	100.0					100.0	S.F. Salmon
	381.6					381.6	Lemhi
Total	631.6					631.6	
McCall					30.6	30.6	Johnson Creek
					30.7	30.7	S.F. Salmon
Total					61.3	61.3	
Mackay				148.9		148.9	Upper Salmon (Decker)
Program Totals	1,377.6	93.0	101.8	227.2	222.2	2,021.8	

Table 5. General Physical Description of Available Water Supplies

Site	Approx. Q (cfs)	Temp. Range (°F)	Source	General Type of Operation
Pasco	40-60	55-60	Existing ground water	Once-Through
Rocky Ford	30	56	Rocky Ford Creek	Once-Through
Lostine			Re-use ground water (1.0 cfs)	Re-Use (120cfs)
Imnaha			Developed ground water (3.0 cfs)	Re-Use (36 cfs)
Powell			Lochsa River	Once-Through
Briggs Springs	106-115	57-58	Briggs Springs	Once-Through
McCall 1/	Unknown	39-50	Big Payette Lake	Once-Through
Mackay	23	47	Warm Springs Creek	Once-Through

1/ *Expansion of existing hatchery.*

Rearing Program for Lower Snake River Compensation Plan
Agency: Washington Department of Fisheries
Location: Pasco

	Fall Chinook	Spring Chinook
Number adults required	6,02[illegible]	131
Survival to spawn	9[illegible]	80%
Number spawning	5,7[illegible]	105
Percentage females 1/	4[illegible]	40%
Number females	2,2[illegible]	42
Number of eggs per female	5,00[illegible]	4,500
Number eggs required	11,450,000	189,100
Survival egg-smolt	80	70%
Number smolts to liberate	9,160,00[illegible]	132,400
Number per pound	90	15
Total pounds liberated	101,800	8,800
Survival smolt-adult	0.2	0.87%
Number returning adults (mitigation)	18,3[illegible]	1,152
Approximate release date	May-June	April-May
Approximate rearing period (months)		

1/ *Sex composition frequently varies from 40 to 60% females hence lower figure is required to assure adequate number of females.*

Requirements of Hatcheries Proposed Under Lower Snake River Compensation Plan

Agency: Washington Department of Fisheries

Location: Main facility--Pasco, Washington
Satellite Facility--Russell Springs, Tucannon River: Township 10N, Range 41 East W.M. in Columbia County, Washington

Land Requirement: 40 acres

Hatchery type: Single pass [✓] ; Re-use [ ]

Egg Incubation

Species	Number of eggs	Incubation Period From	To
Fall Chinook	11,450,000	October	March
Spring Chinook	189,100	August	December

Maximum number of eggs held at any one time 11,639,100

Smolt Production

Species	Smolts at Time of Release Numbers	No./Lb	Lbs	Rearing Period From	To	Total Mos.
Fall Chinook	9,160,000	90	101,800	February	June	5 to 17
Spring Chinook	132,400	15	8,800	December	April	17

Maximum pounds in ponds at any one time 130,000

Adult Holding Facilities (for each area if more than one)

Species	Location	Number of Adults	Holding Period From	To
Fall Chinook	Hatchery	6,026	August	December
Spring Chinook	Tucannon Site	131	May	September

Description of Available Water Supply

Pasco

Ground water is available from collection ditches in downtown Pasco. This water appears to be a result of U. S. Bureau of Reclamation projects and may be increasing in quantity. The U. S. Army Corps of Engineers has the responsibility for pumping this water from the collection ditches into the Columbia, any future work by the Corps in intercepting this water may well be dovetailed easily into a hatchery program in the immediate Pasco area.

An estimated 40-60 cfs of 55-66 F water is presently available.

Tucannon

An estimated 2.5-3.0 cfs is available from Russell Springs. BDF owns the 14.3 acres at this site and has an existing water right of 5 cfs from the springs.

Note: A supportive supply of pumped Columbia River water will be required for smolt conditioning.

Mode of Operation

Present plans call for the release of the entire fall chinook production to be released at the hatchery and all spring chinook from the Tucannon satellite facility. Adults will be collected, retained, and spawned at the points of release. Incubation facilities may be required at the Tucannon site.

Incubation and production tables reflect the program design criteria; however, in actual practice it is likely that both species will be reared to a larger size and, as a result, a lesser egg take will be required to maintain the mitigative poundage-production goal. A more precise estimate of actual incubation needs will be developed when actual engineering and design work is initiated.

2-27-80

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25 1981
VAL FILES

Summary of Hatchery Site Investigations
to Locate a Summer Steelhead Hatchery for
Production of Oregon's Share of the Lower Snake
River Fish and Wildlife Compensation Plan (LSRCP)

As part of the LSRCP the Oregon Department of Fish and Wildlife is to rear 280,000 pounds of summer steelhead. We plan to rear the fish to 6 per pound for a production of 1,680,000 smolts to be released into the Imnaha (330,000) and Grande Ronde (1,350,000) rivers.

A hatchery of the size contemplated would require a site of 30-40 acres of land, a water supply of 78, 40, or 27 cfs depending on whether we have a single, double, or triple pass system. We would prefer a single pass system but this may not be possible.

The water temperature must average 54°F annually to allow us to rear the fish to 6 per pound for release at the end of their first year. The fish would be hauled for release to selected tributaries of the Imnaha and Grande Ronde rivers. Acclimation ponds will be developed in areas which are chosen for adult collection and egg taking sites. No adults are planned to be returning to the site selected for the hatchery. The eggs would be taken at the collection area and hauled green to the hatchery.

Our first choice of a site was the area at the confluence of the Lostine and Wallowa rivers. Well exploration proved the site to be inadequate. Consequently, we surveyed all other known available sites and must make a decision as to the location for Oregon's steelhead hatchery. We also investigated the potential for the concept of reusing the water.

We examined nine sites in Oregon and two in Idaho. Information on these sites and a discussion of the potentials for reused water system is presented in this report, followed by our recommendations.

Lostine-Wallowa. Site No. 1

This site is a 40-acre tract of land located near the confluence of the Lostine and Wallowa rivers. The Corps of Engineers obtained a lease/option to buy from Mr. Renfrow in order to conduct test well drilling. Four wells were drilled and the results were not promising. Estimates were that only 5-6 cfs of water could be developed at this site.

Recommendation: No further study requested.

Wallowa Hatchery. Site No. 2

A search for ground water began in the winter of 1975 when a 6-inch test well was dug. This well, 286' deep, yielded 140 GPM of 52°F water. An additional well, 16-inch diameter, was dug in 1976. This well yielded 4.5 GPM at a depth of 370', 82 GPM at 490', and 145 GPM at 700'. The well was finally drilled to a depth of 1,000 feet in early 1978. At completion, test pumping produced only 140 GPM. Water temperature increased to 61°F as the well was deepened. The Corps believes that our chances are extremely remote for locating sufficient ground water at this site.

Recommendation: No further study requested at this time.

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Grande Ronde, Site No. 3

Ground water searches were conducted in two areas; one in the vicinity of Elgin, the other near La Grande. Preliminary studies indicated that these areas could provide adequate water by pumping to operate a hatchery. However, any additional well development in this area could seriously interfere with existing water supplies. All land owners in the Elgin area refused to sell.

In the La Grande area, 10 landowners were contacted. Only 5 owners responded: 3 were unwilling to sell, while 2 indicated they would sell. The Corps feels that they need 10 wells to supply our needs and that they can locate 5 of them on the property of the willing sellers. They believe that if they can get one other owner to sell, they could develop the 10 wells necessary for a hatchery. However, they are not very optimistic about ever obtaining water rights due to the large amount of water needed and the potential effect on present wells in the area.

The Corps estimates that it would cost $3.7 million to develop a well system capable of producing 27 cfs of 55°F water. The annual pumping costs would be $50,000 (1979 costs). To obtain 40 cfs would cost $6.0 million for development and about $75,000 (1979 costs) annually for pumping.

Recommendation: No further study requested at this time.

Wallowa Lake, Site No. 4

We briefly investigated the possibilities of using Wallowa Lake as a source of water for a hatchery. We came to the conclusion that there are too many unknown factors at this time to adequately evaluate this proposal. Stored water is already over-appropriated, and our greatest use period occurs during the period of storage for irrigation. Also, Pacific Power and Light Company reportedly is planning on reactivating their power plant which was abandoned in the late 1950's. That facility used 15 cfs when available for power generation.

Several people have suggested that with a combination of pumping hatchery effluent back into the lake during storage periods and delivering it to the landowners during the irrigation periods we could locate a hatchery below Wallowa Lake. We would be returning 40 cfs of hatchery water a day for a period up to 90 days to the lake and are concerned about possible harmful effects upon the ecology of Wallowa Lake. We are also apprehensive that water averaging 54°F would be available. We expect the water to be colder than desired. Without a detailed study, we cannot recommend locating a hatchery at this location.

Reportedly, local people would not be receptive to our proposal, and without local support and willing landowners, we or the Corps would not try to proceed with the project.

Recommendation: No further sutdy requested at this time.

Umatilla-Patterson, Site No. 5

This area is owned by the Federal Government and is currently under lease to the U.S. Fish and Wildlife Service, who manages it as a wildlife refuge. It is located adjacent to the Columbia River between the towns of Boardman and

Irrigon. Robinson and Noble, groundwater consultants, concluded that there is good potential for developing 20-50 cfs with water temperatures between 50 to 62°F, with highest temperatures in the fall and lowest temperatures in the spring.

Recent temperatures from two existing wells show temperatures ranging from 59 to 62°F in the summer and fall. The only other data available show temperatures of 59-60°F through the month of February.

The Corps of Engineers believe that 12 wells, approximately 50' deep, located about 500' apart could supply 40 cfs of water at an estimated cost of $1.6 million.

Hauling distance to La Grande area streams would be approximately 135 miles.

Recommendation: Study program should be initiated this spring to incubate summer steelhead eggs and rear the juveniles. We plan to rear up to 30,000 steelhead in this test to make it a mini-production facility.

Opal Springs, Site No. 6

This site is on the Crooked River near Madras. The Deschutes Valley Water District has a rather extensive operation supplying domestic water from these springs. Water temperature is excellent, being a constant 54°F. Although the District's initial response to our inquiries about possibly using the area for hatchery development was not too encouraging, subsequent contact indicated they would allow use of 40 cfs.

There are two possible sites where a hatchery could be built. The upper site is located on a small bench about .5 miles above the District's facilities. Part of this site is privately owned, the remainder is BLM property. The lower site is about .75 mile downstream and is privately owned. Both sites are about 350' higher than the river level. We would prefer the lower site as it is considerably larger and could be expanded in the future and access is easier.

The Corps estimates the cost of developing a pumping station would be $1.5 million and annual power costs would be $250,000. A power generation facility could be built for an additional $1.2 million which would reduce annual power costs to $100,000.

Juvenile steelhead would have to be hauled approximately 290 miles to streams in the La Grande area.

Recommendation: No further study requested at this time.

Crooked River, Site No. 7

The site is several miles upstream from the Opal Springs sites, near the Crooked River Ranch Estates. This property belongs to the Fish and Wildlife Department. Our agency owns approximately 120 acres at the springs and also owns 10 acres adjoining and extending upstream from the spring area. Also, we have special use permits for 40 acres of BLM land and 40 acres of Forest Service land extending downstream from the springs area.

The springs flow at a constant 58°F temperature and could provide ample water for a hatchery. However, the springs are widely dispersed and would

require considerable drilling and pumping. No estimates of costs for development or operation are available, but likely they would equal or exceed those at Opal Springs. Power generation could not be used to offset these costs as our deed requires that if the springs are developed, the water must be delivered after our use to local landowners for irrigation.

Hauling distance for young steelhead to La Grande would be about 285 miles.

Recommendation: No further study requested at this time.

Oak Springs Hatchery, Site No. 8

This facility was investigated as a possible way to rear part of the summer steelhead production for the Snake River Compensation program. Several reasons prompted our examination of this facility. We knew that substantial numbers of fish were reared, or started and then transferred, for use in the Willamette Basin. Our thought was that some or all of these fish could be transferred to an expanded Willamette facility.

A look at recent records indicated that Willamette fish constituted 43% of numbers and 25% of poundage produced at Oak Springs. Because so many fish, both catchables and summer steelhead, were started at differing times and moved out as fry, fingerlings, smolts, etc., we could not determine precisely what quantity of water was used for Willamette fish.

Estimates are that a total of 30 cfs of spring water ($54^{o}F$) can be developed at Oak Springs, and that we are currently using 20 cfs of this. The estimate of 10 cfs remaining for development was a very subjective one, and hydrological investigation could disclose the presence of considerably more water.

Hauling distance to La Grande area streams is about 205 miles.

Recommendation: Evaluate potential available and amount used. This study needed for either the LSRCP or a state program.

Hagerman National Fish Hatchery, Site No. 9

This hatchery, located in Idaho, is owned and operated by the U.S. Fish and Wildlife Service. The facility will have the capability of rearing 300,000 pounds of summer steelhead and 100,000 pounds of trout. Idaho has considered this hatchery for rearing a portion of their steelhead, and rearing the remainder at the Malad site, which will be discussed following this section. When Idaho has firmed up their summer steelhead program, it is possible that part or all of our fish could be reared at this facility. However, there is the possibility of problems with IPN and IHN at Hagerman. We feel our pathologist would have to investigate the prevalence of these viral diseases before we would consider using this facility and transporting fish to Oregon streams.

If we were to select Hagerman for rearing, we would prefer to run the station. If this could not be arranged, we would want a contract allowing us control over rearing procedures.

Hagerman is located about 285 miles from La Grande.

Recommendation: Evaluate incidence of virus in Hagerman Valley and the effect on summer steelhead as related to use in Oregon streams.

Malad, Site No. 10

This site is located in Idaho near Hagerman Trout Hatchery which is operated by the Idaho Department of Fish and Game. The site is being considered by Idaho for rearing part of their summer steelhead. Initially, they believed they would be able to develop only 20 cfs at Malad. Recent investigations lead them to believe that they can obtain 100 cfs of 59°F water capable of rearing 600,000 pounds of summer steelhead by their standards. As mentioned under the Hagerman National Fish Hatchery section, it is possible that all or part of Oregon's steelhead could be reared at this site. Again, we would prefer to operate the facility or, at the very least, have contractual control over fish rearing procedures.

Malad may have IPN or IHN present and would have to be investigated by our pathologist.

Malad is located about 275 miles from La Grande.

Recommendation: Same as for Hagerman.

Snipe Creek, Site No. 11

This is an irrigation project proposed by the Butter Creek Irrigation Association. The project as proposed entails a 130' high dam, with a storage area of 260,000 acre-feet covering an area of 4,400 surface acres. The dam site is located on Snipe Creek, tributary to Camas Creek, John Day River, about 6 miles north of the town of Ukiah. A 30' high dam would be located on Camas Creek to divert water into a 7-mile-long canal which runs into the proposed Snipe Creek Reservoir. Stored water would be made available to the farmers via Butter Creek.

ODFW personnel met with sponsors of the proposed project and Corps representatives on October 18, 1979. The sponsors invited us to participate financially in the project in order to use water from the reservoir for a summer steelhead hatchery. Even if the project was viewed favorably by our department, we have serious reservations regarding the quantity and quality of water available from the proposed project. The Northeast Region is opposed to the project because of possible damage to the fish resources of the John Day River system.

Recommendation: No further study requested at this time.

Reuse Hatchery

To obtain information on the reuse water system for operating a hatchery, we contacted the following people: Dick Pressey, formerly with the Environmental and Technical Services Division of NMFS and presently a consultant with UMA, Portland; Laurie Fowler, U.S. Fish and Wildlife Service, Abernathy, Washington; Bob Piper, U.S. Fish and Wildlife Service, Bozeman, Montana; David Owsly, U.S. Fish and Wildlife Service. Dworshak Hatchery, Idaho; Elmo Barney, U.S. Fish and Wildlife Service, Spring Creek Hatchery; and Ron Goede, Cooperative Fisheries Unit, Utah State University at Logan. We briefly reviewed our investigations of sites in Oregon and Idaho and discussed the limitations of

each. We requested their candid comments on the advantages and disadvantages of going to a reused water system.

All responded that the only time it would be advantageous to go to a reuse system would be when there was absolutely no water of the quantity and quality desired. They felt that a reuse system could never be justified on the basis of economics as power costs for pumping, chilling, and heating are still extremely high. For example, one Utah hatchery of 100,000 pounds production capability has an annual power bill of $50,000.

Most of those interviewed felt that a frequent cause of problems was the filtration system. These ranged from a "wearing out" or breakdown of the filtering medium itself to maintaining adequate bacteria for nitrofication. Apparently, the bacteria are extremely susceptible to temperature and oxygen changes. In addition to filtration, it may also be necessary to have an ultraviolet system to sterilize the water if diseases are present or are inadvertantly introduced.

Without exception, all of those interviewed endorsed our recommendation for a pilot study at Umatilla-Patterson. They felt that the temperature range of 59-62°F was not a major problem, and several cited experience of successfully rearing rainbow/steelhead at even higher temperatures.

We recommend no further investigation of the reuse system at this time.

Recommendations

After reviewing available information on 11 potential hatchery sites and possible use of a reuse water supply, we recommend the following:

1. Initiate a pilot hatchery study at the Umatilla-Patterson site. This should be done as soon as possible and should include both incubation (chilled water) and rearing. The Corps views this proposal with favor and has money available for funding.

2. Conduct a study at Oak Springs to determine potential water development and amount currently being used. It is possible this facility could rear one-third our required production. Also, it should be investigated for possible future expansion even if not used for this program.

3. Our pathologist should conduct an investigation to evaluate the incidence of viral diseases in Hagerman Valley and the effect on summer steelhead.

Summary of Fish Rearing Facilities as Proposed by Columbia River Fisheries Agencies

The attached 2 tables summarize fish rearing projects in 2 categories. Table 1 lists 12 hatchery-related projects and Table 2 lists 26 rearing pond projects. Most of the preliminary planning was done with the Magnuson add-on provided in FY 1976. The agencies doing the work were asked to give the projects priorities, but most of them were reluctant to assign a numerical rating other than No. 1 and No. 2 projects.

Planning reports on all of these proposed facilities are available in the Environmental and Technical Services Division Office of the National Marine Fisheries Service, with the exception of the proposal by the Oregon Department of Fish and Wildlife to build an adult holding station on the Clackamas River. Plans for the project are currently being prepared by ODFW engineers with State funds. The proposed Ringold Springs trapping facility by the Washington Department of Fisheries will probably be constructed this coming year with State funds or funds derived from salmon carcass sales from Columbia River hatcheries.

Washington Department of Game lists their No. 1 priority as the enlargement of their Goldendale Hatchery. However, the cost of this project is quite high and if funds are not available in this magnitude, they will substitute the rearing pond on the East Fork of the Lewis River as their top priority. Several projects are not listed that were investigated and discarded because it was immediately determined they were incapable of rearing fish. Costs of construction on all projects are rough estimates and structural designs would have to be completed before accurate figures could be determined.

January 1979

January 19

Following is a list of [illegible] were evaluated by the States and the Fish and Wildlife Service for increasing production by modification of existing fisheries or by building completely new fish culture stations

Station	Type of Facility	Production	Cost	Priority
Fish and Wildlife Service				
Carson National Fish Hatchery	New intake water conduit		250K	Medium
Little White Salmon National Fish Hatchery	Develop groundwater - minimum 300 gpm	Water to be for winter rearing	40K	Test well drilled producing 400 gpm
Carson Depot Springs	Satellite ponds for Little White Salmon	15,000-30,000 pounds	250K	Being developed by USFWS
Abernathy	Develop additional groundwater	Present well showing depletion	80K	High
Oregon Department of Fish and Wildlife				
Adult Holding Pond Clackamas River	New construction upstream from hatchery - 55° water	Satellite to Clackamas & Eagle Creek hatcheries	300K	Highest priority of [illegible] facility listed for [illegible]
Klaskanine Hatchery	Filtration system and incubators	Early rearing - 1-2 million chum 7.0 million fall chinook 1.2 million coho	180K	Oregon No. 2 followi[illegible] Clackamas holding po[illegible]
Washington Department of Fisheries				
Ringold Springs	Adult Trapping facility	Improved operations	40K	No. 1 priority - WDF
Toutle Hatchery	New adult holding facility	Improved operations	150K	No. 2 priority - WDF
Toutle Hatchery	New water intake	Improved operations	155K	High

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Hatchery	Type of Facility	Production	Cost	Priority
Washington Department of Game				
Ellsworth Springs	Complete new station - 8 rearing ponds	30,000 lbs. Steelhead smolts 5 fish/lb.	2061K	High
Goldendale Hatchery	Enlargement of present station	45,900 lbs. Steelhead smolts 5 fish/lb.	600K to 2091K	WDG No. 1 priority
Joint Project (WDF and WDG)				
Bingold	Intake structure to utilize [illegible] cfs from Hillside Springs	Improved rearing	[illegible]	High [illegible] joint project

Following is a list of capital projects that were evaluated by the States and the Fish and Wildlife Service with th objective of increasing salmon and steelhead hatchery production in the Columbia River. Funds for these investigat were provided by a special appropriation in Fiscal Year 1975, sponsored by Senator Magnuson of Washington.

Washington Department of Fisheries

Rearing Ponds (Washington)	Size and Type	Annual Production	Cost	Priority
Klickitat Salmon Hatchery	1.2-acre hypalon-lined	30,000 lbs	Plan a - 170K Plan b - 215K Road a and b - 60K	High
Klickitat Acclimation Pond	0.7-acre - dirt	Aid in survival of hatchery production	440-460K	Medium
Toutle	2 ponds - dirt 1-acre, 1.2 acre	200,000 lbs	330K	High - Being const ed with State fund
Weyco Pond	Added water supply to existing 3-acre pond	30,000 lbs	Plan a - 240K Plan b - 370K	Low - State would to purchase land f Weyerhaeuser Compa
Megler Pond	Tidal dirt pond 16.7 acres	300,000 lbs	1,280K Alternate a - 820K	High
Dog Creek	10-acre dirt	1.2 million chinook, depending on water supply	230K	Medium
Dog Creek No. 2	0.7 acre	?	?	To be investigated site located when investigating No.
Kalama No. 1 Alternate No. 1	1-acre - dirt 1-acre - dirt	50,000 lbs 50,000 lbs	460K 210K	Low - Purchase of land necessary
Kalama No. 2 Alternate No. 2	1-acre - dirt 1-acre - dirt	50,000 lbs 50,000 lbs	680K 450K	Low - purchase of land necessary
Wild Horse Creek (Trib. to Kalama River)	0.5-acre	30,000 lbs	110K Plus land purchase	High - good site
Lewis River	Two pond sites investigated and rejected - iron content in ground water too high			

Pl[illegible] of
Ta[illegible]

Rearing Ponds (Oregon)	Size and Type	Annual Production	Cost	Priority
South Fork of Klaskanine No. 1	2 ponds - dirt 180' x 60'	2.0 million chinook or 500K coho	50K plus land	High
South Fork of Klaskanine No. 2	2 ponds - dirt 180' x 70'	2.4 million chinook or 600K coho	60K plus land	High
Plympton Creek	3-acres	water record showed inadequate flow plus extensive diking - site discarded		
Youngs River No. 1	6 ponds - dirt 300' x 50'	Inadequate water for coho 7.0 million fall chinook	300K plus land	High
Youngs River No. 2	2 ponds - dirt 180' x 60'	2 million fall chinook only No coho	50K plus land	High
Youngs River No. 3	2 ponds - dirt 175' x 50"	1.5 million fall chinook	50K plus land	Medium
Youngs River No. 4	2.5-3.0-acre pond	4 million fall chinook	60K plus land	Medium
Stayton Pond	2-7-acres	8-10 million chinook	300K plus land	ODFW No. 3 priority following Clackamas Klaskanine projects

Rearing Ponds (Wash. Game)	Size and Type	Annual Production	Cost	Priority
East Fork of Lewis River	.8-acre - dirt	150,000 SH smolts	248K	High
Elochoman	1.25-acre - dirt	100,000 SH smolts	232K	High
Coweman River (Baird Creek)	1.25-acre - dirt	100,000 SH smolts	197K	High
North Fork of Lewis River	1-acre - dirt	100,000 SH smolts	258K	High
South Fork of Toutle River	1.25-acre - dirt	150,000 SH smolts	238K	Good
Klickitat River (Stinson Flat)	1-acre - dirt	200,000 SH smolts	191K	Good

*The above ponds would be used as short-term rearing and release ponds. Steelhead smolts are usually 5 fish to the p

Task 4.1.2: Identify additional water supplies at existing hatcheries for increased production.

A precursory survey was conducted of existing Columbia Basin fish hatcheries to determine the availability of additional water supplies which would allow expansion and increased fish production. This expansion could potentially be used for compensation of fish passage losses at Columbia River dams. Hatchery water supplies with potential for micro-hydroelectric generation were also documented. The task was accomplished through interviewing personnel of the fishery agencies operating the various hatcheries. Table 1 provides the qualitative results of the survey.

The sites where additional water supplies are available should be examined in a comprehensive research investigation. Exact amounts and periods of availability of water should be determined. Water quality and limiting factors should be evaluated. Design of facilities for expansion at each site should be developed and the numbers, pounds, and species of fish to be reared determined.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program a detailed, comprehensive survey of existing hatcheries utilizing power revenues to determine each's potential for expansion.

Table 1. Survey of Columbia Basin Fish Hatcheries' Water Supplies for Possible Expansion in Fish Production and for Power Generation

Agency	Hatchery	Water Source		Power Potential
		Ground Water	River Water	Hydroelectric
USFWS	Abernathy	No	No	No
	Carson	Yes 1/	Yes 1/	No
	Dworshak	No	Yes 2/	No
	Eagle Creek	No	No	Yes
	Entiat	No	Yes	No
	Hagerman	No	No	No
	Kooskia	No	No	No
	Leavenworth	No	Yes	No
	Little White Salmon	Yes	Yes 3/ 4/	Yes
	Spring Creek	No	No	No 5/
	Warm Springs	No	Yes	No
	Willard	No	No	Yes
	Winthrop	Yes	Yes	No
WDG	Beaver Creek	No	No	No
	Chelan	No	No	No
	Cowlitz Trout	No	Yes 6/	No
	Goldendale	Yes 3/	No	No
	Mossyrock	No	Yes 6/	No
	Naches	Yes	No	No
	Ringold Trout	Yes 7/	No	No
	Skamania	No	No	No
	Tucannon	No	Yes	No
	Vancouver	No	No	No
	Wells	No	No	No
	Yakamia	No	No	No
WDF	Cowlitz Salmon	No	Yes 6/	Yes
	Elokomin	No	No	No
	Grays River	No	No	No
	Kalama Falls	No	No	No
	Klickitat	Yes	Yes	Yes 8/
	Lewis River	Yes 9/	Yes 2/	No
	Lower Kalama	No	No	No
	Priest Rapids	No	No	No
	Ringold Salmon	Yes 7/	No	No
	Rocky Reach	No	No	No
	Speelyai	No	No	No
	Toutle	- 10/	-	-
	Washougal	No	No	Yes
	Wells Salmon	No	No	No

Agency	Hatchery	Water Source		Power Potential
		Ground Water	River Water	Hydroelectric
ODFW	Big Creek	No	Yes 3/	No
	Bonneville	No	No	No
	Cascada	Yes 11/	No	No
	Clackamas	No	Yes 6/	No
	Gnat Creek	No	No	No
	Klaskanine	No	No	No
	Leaburg	No	Yes 4/	No
	Marion Forks	No	No	No
	McKenzie	No	Yes 4/	No
	Oakridge	No	No	No
	Oak Springs	Yes	No	No
	Oxbow	No	No	No
	Roaring River	No	No	No
	Round Butte	No	Yes 6/	No
	Sandy	No	No	No
	South Santiam	No	Yes 4/	No
	Wallowa	No	No	No
	Wahkeena Pond	No	Yes 12/	No
	Wizard Falls	Yes 6/	No	No
IDFG	American Falls	No	No	No
	Crystal Springs	Yes	No	No
	Eagle	No	No	No
	Hagerman	Yes	No	No
	Hayden Creek	No	Yes 13/	No
	Mackay	No	No	No
	McCall	No	Yes 4/	No
	Mullen	Yes 11/	No	No
	Niagara Springs	No	No	No
	Pahsimeroi	Yes 1/	Yes 1/ 3/	No
	Rapid River	No	No	No
	Sand Point	No	Yes	No

1/ Limited amounts

2/ Would require purchase of additional land

3/ Seasonal only

4/ Requires additional water right

5/ No hydroelectric but wind-generated electricity is being investigated

6/ Disease or temperature problems

7/ Being considered by both WDF and WDG

8/ Huda D.C. generator attached to water supply in the past

9/ High in iron

10/ Currently not in operation due to eruption of Mt. St. Helens

11/ Pending study

12/ Not currently being used due to lack of funding

13/ Currently operated at less than capacity for existing water supply

JOHN SPELLMAN
Governor

FRANK LOCKARD
Director

STATE OF WASHINGTON
DEPARTMENT OF GAME

September 10, 1981

MEMORANDUM

TO: Bill Hopley, Salmon Culture Division
Department of Fisheries

FROM: Jim Gearheard, Fisheries Management Division
Department of Game

With regard to artificial production of anadromous game fish relative to the Northwest Power Bill I would like to list the following possible projects:

1. Restoration of steelhead to suitable areas above Chief Joseph Dam: There is potential with present technology to provide steelhead adults to streams such as the Spokane River, San Poil River, Pend Orielle River, Kettle River, Colville River, Deep Creek and Big Sheep Creek. The Department of Game has a hatchery site at Waikiki Springs in Spokane with sufficient water to rear 400,000 to 500,000 steelhead smolts annually. The smolts could be trucked to an acclimation pond near Chief Joseph Dam and released to the Columbia River. Returning adults would be collected at the acclimation pond site and trucked to the streams where they could provide a sport fishery as well as possibly an Indian fishery. Some adults would be retained to provide eggs for the program.

2. Expansion of Ringold Rearing Pond: Potential exists to reconstruct the water system and rearing pond to rear an additional 100,000 smolts.

3. Expansion of Goldendale Hatchery: There is potential here to rear a 150,000 smolt program for the Klickitat River.

4. Ellsworth Springs Hatchery. This potential hatchery site could be developed to provide fry for lower Columbia River steelhead rearing programs.

5. Lewis River Rearing Ponds: A site has been identified near the Lewis River which could be used to rear steelhead smolts.

JG:la

cc: Fred Holm
Jim DeShazo
John Hisata
Bruce Crawford
Gary Fenton

Task 4.1.3: Prioritize potential hatchery sites based on water quantity and quality, species need, and management considerations.

Introduction: Considerable effort has been expended in recent years on selection of hatchery sites for various projects such as the Lower Snake River Fish and Wildlife Compensation Plan (LSRCP) and Washington State's Salmon Enhancement Program. Site selection is often based solely on availability of adequate water of acceptable quality and this criterion is, of course, basic to hatchery success. There are, however, increasing restrictions on the utility of any potential hatchery site including excessive operating costs, pumping costs, transportation costs, harvest management requirements, construction costs, competing water users, and species distribution requirements. The situation becomes more complex when site selection must meet requirements of several managing authorities such as could be expected with mitigation and compensation efforts throughout the Columbia River Basin. For example, site selection for LSRCP hatcheries was based on very specific species and distribution requirements to replace fish in the area and to the degree affected by water project construction. In this instance the basic requirement for quantities of quality water was further constrained by specific location and application requirements. The LSRCP approach might be considered an example of the approach to be expected in Columbia River compensation and mitigation under the Power Act.

For the purpose of meeting hatchery compensation objectives within the scope of the Power Act it will be necessary to develop a prioritizing system by which to select appropriate hatchery sites from those identified through 4.1.1. The selection would be based on mitigation and compensation requirements, harvest management requirements, species distribution requirements, water quantity, and water quality. This prioritizing system must be broad enough to encompass all agencies and groups affected under the umbrella of the 4(h) provisions of the Power Act.

Status: Each state, federal, and Indian fisheries managing authority has in-house priorities by which site selection decision is made including

biological, management, and political considerations. These agency priorities, however, are not necessarily of general acceptability to other agencies which has its own varying goals, objectives, and requirements. Several documents exist setting out criteria for hatchery site selection. Coverage ranges from discussion of generalized principles of species distribution such as found in LSRCP documents (1) to specific biological requirements as presented in the Mid-Columbia River study (2). A myriad of research papers could be assembled addressing water quality requirements, toxicity levels, etc., possibly with both general agreement for some species requirements and wide ranging disagreement for other requirements. At present, no approach for prioritizing hatchery site selection has been developed that would be broad enough in scope to address a comprehensive hatchery development program under the Power Act.

Needed Research: Because no broad concensus has been established among all participating parties at either the level of species-specific biological requirements in the hatchery, or the objectives that hatcheries are to fulfill under the auspices of the Power Act, a study with the following objectives must be initiated:

A. Establish the set of management objectives to be met by artificial production techniques including priorities for reaching these objectives.

B. Establish a set of species-specific biological criteria necessary to artificial production of anadromous fish (salmon and trout species).

C. Establish guidelines for reasonable limits of expenditure to be made in reaching objectives under A.

D. Establish a decision-making process by which a proposed hatchery site can be properly evaluated for its potential in meeting management and compensation-mitigation priorities set out in A, biological criteria set out in B, reasonable economic constraints set out in C, and legal requirements of various user groups.

Anticipated Results: The product resulting from this study would be a set of biological and economic criteria for artificial production facilities, a prioritized set of objectives to be met by use of artificial production facilities, and a decision system by which to judge the viability of a proposed hatchery site and its applicability in meeting compensation-mitigation objectives under 4(h) and management requirements. A decision team would also be established with responsibility for developing the priority system and exercising the decision process.

Scope of Work: Study objectives A through D would best be accomplished by assigning two different work teams. Team No. 1 should address recommendation A which deals with long-term objectives to be met through hatchery production. This team would be made up of agency management interests, for example, the Columbia River Basin Fishery Technical Committee of the Columbia River Fisheries Council or a committee with expertise similar to that contained in the Tech Committee.

Recommendations B through D should be assigned to a second work team having expertise in salmonid fish culture similar to that contained in the Artificial Production Committee of the Columbia River Fisheries Council. This group would have responsibility for developing biological and economic criteria as well as implementing the prioritizing system for site selection. Team No. 1 above, would provide the results of their efforts to Team No. 2 in the form of directions to meet long-term compensation-mitigation and fishery mangement goals.

Specific activities are outlined below with the caveat that this outline probably does not cover all topics of concern.

I. Funding proposal developed by a fishery administrative committee or appointee and presented to Bonneville Power Administration-Power Planning Council.

II. Power Planning Council sanctions and funds objectives A through D.

III. Fishery Administrative Committee assigns two working teams with appropriate expertise.

IV. Team No. 1 performs:

1. Production requirements and objectives

   a. Levels of production necessary to meet requirements.
   b. Species-specific production levels.
   c. Geographical distribution of production by species.
   d. Develop priority for production by species and by geographical area; which production objectives are to be met first, second, etc.
   e. Harvest management requirements.

2. Provide priority directions for meeting objectives to Team No. 2.

V. Team No. 2 performs:

Objective B - Establish biological criteria for hatcheries.

1. Water quantity by species

   a. Loading.
   b. Density.

2. Water quality by species

   a. Temperature ranges.
   b. Dissolved gas levels.
   c. Toxicant levels.

3. Brood stock requirements

   a. Genetic restrictions.

i. stock transfers.
ii. spawning populations.

4. Species interactions

a. Intra-species.
b. Inter-species.

5. Habitat limitations

a. OPI

Comment: A set of water quality criteria is attached that can be used as an example of required information.

Objective C - Economic criteria

1. Cost criteria.

a. Energy costs.

i. Limit pumping use.

a) maximum expenditure
b) maximum percent of O&M costs.

ii. Disallow pumping.

b. Construction costs.

i. Accessibility of site.
ii. Maximum capital cost.

c. O & M Costs

i. Labor intensive facility.

ii. Water treatment.

a) Source.
b) Recirculate.
c) Multiple pass

iii. Transportation.

a) Deliveries.

i) Fuel
ii) Feed

b) Fish transport.

i) Off-station plants.
ii) Transfer to satellites

iv. Heating-cooling of facilities.

2. Benefit-cost criteria

a. Must B:C exceed 1:1?
b. What is acceptable or rational () B:C ratio? Establish.

Comment: A detailed listing of considerations of hatchery sites is attached.

Objective D - Decision System

1. Team No. 2 is to develop a decision system to test the potential of a proposed site to meet Team No. 1 production and management priorities, giving proper weight to biological factors while meeting minimum economic responsibilities.

VI. Selected hatchery sites processed through Tasks under Subobjective 4.2 and Power Planning Council.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program a study funded by power revenues to determine criteria for artificial production facilities required for compensation of unavoidable power related fishery losses.

Attachments

HATCHERY SITE INVESTIGATION REPORT OUTLINE

I. General Description

- A. Geographic Area
  - 1. Site Location
  - 2. Release Location
  - 3. Fishery Location
  - 4. Soil Types
- B. Proximity to Services
- C. Proximity to Urban and Industral Development
- D. Natural Elements
- E. Relationship to Existing Facilities
- F. Political Requirements
- G. P-R Requirements
- H. Reduce Natural Mortalities (Pollution, Predators)

II. Water

- A. Fresh or Salt
- B. Gravity
- C. Pump
- D. Source
  - 1. Well Water
  - 2. River Water
  - 3. Spring Water
- E. Quality
  - 1. Test
  - 2. Presence of Aquatic Life
- F. Quantity
  - 1. High Flow
  - 2. Low Flow
- G. Temperature

III. Facilities

A. Incubation

1. Species

2. Numbers

3. Water

a. Quality

b. Quantity

c. Controlled Temperature

4. Type of Units

5. Disease Controls

B. Rearing

1. Species

2. Numbers

3. Size

4. Water

C. Pond

1. Number of Units

2. Type and Size

D. Feed and Feeding Procedures

E. Effluent

F. Disease Control

G. Release

1. Species

2. Time

3. Size

4. Location

5. Fish Quality

6. Fish Quantity

7. Environmental Condition

8. Method of Release

9. Interaction with Other Species and Natural Stocks

H. Adult Trapping

1. Type

a. Gaffing

b. River Barrier and Trap

c. River Barrier and Diversion Fishway

d. River Barrier and Effluent

e. Effluent Only

f. Barrier and Seining

g. Fishway Trap with Hauling

2. Holding Facilities

a. Water Quality

b. Water Quantity

c. Pond Type

(1) Earthen

(2) Concrete

(3) Automated

I. Equipment

1. Housing and Services

2. Hatchery or Building

3. Freezers

4. Auxiliary Standby Generator Yes or No

5. Shop

6. Storage

7. Feeders

8. Trucks

9. Tools

10. Screens (Pond)

a. Flat

b. Powered

(1) Belt

(2) Drum

11. Intake

12. Supportive Equipment

IV. Ownership and Costs

A. Land

1. Quantity

2. Purchase Cost-Future Value

3. Development Costs

B. Facility Development Costs

C. Facility Cost - Benefit Ratio

D. Labor Requirements

V. Production Recommendations and Potentials

A. Refer to Table on Smolt Production

B. Fishery(ies) to Serve

C. Species and Species Interaction (Biological & Political)

D. Magnitude of Contribution

E. Optimize Natural and Hatchery Harvest

FROM: Lower Snake River Fish and Wildlife Compensation Plan, Design Memorandum No. 1. Fish Facilities Site Selection Report. U.S. Army Corps of Engineers, Walla Walla District, November, 1977.

SECTION 4 - SITE SELECTION CRITERIA

4.01. GENERAL

a. The general locations of the hatchery and associated facilities should be based on the species of fish to be compensated and the stream area of their origin. The general area where fish losses have been induced by the Lower Snake River Project, and the magnitude of these losses, is shown on Table 2 of Appendix A of this report. These estimates were made by the Columbia Basin Fisheries Technical Committee. [illegible] effort should be made to locate the hatchery facilities as close to the [illegible] as possible. For a fish hatchery, it is essential to obtain an adequate water supply of acceptable quality, and because of the large quantity of water needed, location of a suitable water supply is the [illegible] restraint in site selection. In much of the area being considered for fish hatchery location, particularly in Idaho, there is competition with large commercial fish-rearing operations.

b. Since land acquisition for the Fish Compensation Plan is on a willing buyer-willing seller basis, hatchery and satellite sites should be located on U.S. Government-owned land if possible. The sites should be located in the lower elevations where feasible in order to avoid adverse weather conditions. They should be located outside of the 50-year flood plain of the adjacent river or stream. For year-around access for fish hauling, visitors, and suppliers of feed and fuel, the hatcheries should be located near paved state highways or county roads requiring only limited access roads to the hatcheries. [illegible] fish rearing, hatcheries should be located, where possible, on the stream or river where the fish will be collected and [illegible] by means of fish ladders directly from the fish [illegible].

c. However, for many of the [illegible] it will not be possible to have a direct hatchery return of migrating adults. Therefore, in order to maintain a fishery having qualities unique to a particular stream, adult fish must be trapped on the stream for spawning purposes. To do this, satellite facilities must be provided on the streams in which fish runs are to be maintained to allow trapping of upstream migrating adults. The facilities should be located such that the major portion of the natural spawning beds are downstream of the facility if possible. This will reduce costs as the design flow of the barrier dam will be smaller than downstream locations.

d. In some hatchery-satellite facility combinations, the adults will return directly to the hatchery, but smolts will be trucked to the satellite facility to acclimate them to the adjacent stream water to which they will be subsequently released. These satellite facilities will normally be only earthen holding ponds. For this combination, the hatchery and satellite facilities need to be as close as possible to reduce transport distance. On all satellite locations, preference will be given to sites where gravity

water flow can be used. This is desirable to reduce operating costs and conserve energy. In some cases these satellite stations are remote and no commercial power is available.

e. Finally, in comparing alternative hatchery and satellite facilities, economic and environmental factors will be considered. However, based on experience to date, finding adequate, available sites for the necessary compensation requirements is of real concern.

4.02. WATER SUPPLY

a. The source of water for a hatchery can be surface water, ground water pumped from wells, a spring, or a combination. Surface water is normally the least desirable because of temperature fluctuations and the higher possibility of becoming contaminated. Because of the problems with hatcheries where water is recycled, single pass hatcheries are much preferred. This means that the proposed hatcheries will have very high water requirements, in some cases in excess of 100 cfs. Determining if adequate ground-water supply is available to yield these flow levels is expensive and time consuming.

b. To use surface water, with the possible exception of lakes, normally requires both heating and cooling. For the flows required for a single pass hatchery, this is infeasible because of the high energy requirements and operating costs.

c. There are large springs in south central Idaho which yield sufficient quantities of water. However, this water is already appropriated. In many cases it is being used for fish hatchery purposes. The largest springs are in the vicinity of the Briggs Springs site (see Plate 1). This water appears to be uniformly 58 degrees Fahrenheit which is suitable for a steelhead hatchery.

d. It is for the reasons cited above that locating a suitable water supply was identified as a major restraint on site selection.

4.03. WATER QUALITY REQUIREMENTS

General water quality parameters and limits for fish hatchery operation have been established through research studies and actual hatchery operation. The major considerations include temperature, dissolved oxygen, pH, and presence of disease organisms or toxic substances. Water temperature at certain times of the year is a limiting factor in most streams. The ideal hatchery site would have a sufficient quantity of water of a limited temperature range to produce optimum growth of fish and be within the limits of other water quality criteria. Preliminary water quality investigations were made at each of the sites presented in this report and each site was acceptable within the limits of the parameters tested. A full water quality analysis will be made, however, before detailed design of a site is begun. It is possible that some criteria may not be met during this analysis which would necessitate choosing an alternate site which would be described in a supplement to this report.

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FROM: Mid-Columbia River Study. Part 1: Hatchery Siting Survey. Frederiksen, Kamine and Associates, Inc. Chelan Co. PUD, Douglas Co. PUD, Grant Co. PUD. March, 1981.

TABLE 1

HATCHERY SITING CRITERIA USED AS A GUIDE
IN LISTING FISH CULTURE UNITS FOR THE MID-COLUMBIA AREA

Criteria	Full Hatchery Complex	Satellite
Temperature (°F)		
Adult holding	Below 58 in later stages	Same
Incubation	42-58	Same
Newly pond fry	44-60	Same
Chinook rearing age "0"	46-60	Same
Summer temperature	Less than 60	Same
Winter temperature	Above 32	Same
Steelhead smoltification	Below 55	Same
Water Volume (Minimum)		
Incubation	1 cfs (450 gpm)	Same or more
Rearing at smoltification	10 cfs (4500 gpm)	5 cfs
Summer/winter	Less could be available	5 cfs
Water chemistry	FK used Table 2 as a guide	Same
Pathology	FK used the manual by James W. Wood (1979)	Same
Cost		
Capital Cost	As a guide FK used WDF criteria (Williams and Kiser, 1979)	Same
O&M	Same as above. Consideration was given to pumping costs, trucking costs, and operational costs due to location.	Same

TABLE 2

ACCEPTABLE WATER CHEMISTRY LIMITS FOR TROUT AND SALMON CULTURE
(WDF revised 1/2/78)

Water Chemistry Test	Acceptable Upper Limit for Continuous Exposure
Hardness, Ca	*
Hardness, total	*
Lead	30 ppm
Nitrate	5-10 ppm
Nitrite	100 ppm
Calcium	10-20 ppm
Chloride	*
Sodium	*
Potassium	*
Magnesium	*
Phosphates, ortho	*
Acidity	(6.8 - 8.5)
Alkalinity, total hardness	At least 20 ppm (as $CaCO_3$)
Ammonia	0.02 ppm
Cadmium	0.0004 ppm in soft water (<100 ppm alkalinity)
Cadmium	0.003 ppm in hard water (>100 ppm)
Chromium	0.03 ppm
Copper	0.006 ppm in soft water; 0.003 ppm in hard water
Zinc	0.01 ppm in soft water, .05 ppm in hard water
Hydrogen sulfide	0.002 ppm
Lead	0.03 ppm
Mercury (organic or inorganic)	0.2 ppm maximum, 0.05 ppm average
Nitrogen	Maximum total gas pressure 110%
Polychlorinated biphenyls (PCB's)	0.002 ppm
Total suspended and settleable solids	80 ppm or less
Iron	0.5 ppm
Nitrate	10 ppm
2-4 D	4 ppt
Malathion	.008 ppt

* Upper limit has not been established by WDF.

Subobjective 4.2: Construct artificial production facilities at determined locations.

Subobjective 4.2 will implement construction at hatchery sites evaluated and selected under Tasks 4.1.1., 4.1.2. and 4.1.3. A sequential set of instructions for identification, design, and construction of hatchery facilities at approved sites will be presented. Required funding will be obtained from Bonneville Power Administration or other responsible power authority for all phases of design, construction, and annual operating costs. This hatchery compensation would fulfill compensation requirements justifieid under the Phase I discussion in Chapter G.

Entries under Task 4.2.1 will be made by agencies with specific construction proposals. The Corps of Engineers has indicated that because of the magnitude of a program resolving complete mitigation for their four lower Columbia River projects it would be advisable to develop such a program by phases. With current losses averaging 20 - 25 percent per dam, a first phase based on compensation for a 5 percent mortality per dam should be instituted without requiring any more time-consuming studies to assess and justify the program. In practice, the number of submissions for immediate construction is not likely to meet a 5 percent per dam level.

Tasks 4.2.2 and 4.2.3 detail a design and construction progression that is straightforward. In general, agencies will secure funds for design and construction and would administrate the projects through service contracts with private vendors. This method is now in use by Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, Idaho Department of Fish and Game, and Washington Departments of Fisheries and Game to construct hatcheries under the Lower Snake River Fish and Wildlife Compensation Plan.

Task 4.2.4 provides for annual funding of operations and maintenance cost by Bonneville Power Administration or other funding authority. Funds will be provided to the fisheries agency or tribe which will be the sole operator of the facility.

In review, agencies submitting proposals for construction of artificial production facilities will receive monies through power rates from Bonneville Power Administration or other power entities. The agencies will be responsible for administrating design and construction. After construction, the ownership of the facility will pass to the operating agency and operating funds will be provided annually by the responsible power entity.

Task 4.2.1(a): Fall Chinook Acclimation Pond

Background: The Bonneville and Spring Creek fish hatcheries were expanded to provide compensation for the loss of habitat due to construction of the Jon Day Dam. The fishery affected had been traditionally fished by the Columbia River treaty tribes. Current operation of these hatcheries deprives the tribes of their 50 percent treaty fishery rights not only to the bright fall chinook originally lost with the inundation, but by Spring Creek Hatchery only rearing and releasing tule fall chinook, a low-quality fish that is currently harvested by the treaty fishermen.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program restoration of losses to the treaty fishery resulting from the construction of the John Day Dam; the Bonneville hatchery and the Spring Creek hatchery will be operated to rear fish for release in the John Day Pool. For example, the existing spawning channel below McNary Dam could be modified to provide an acclimation pond for planting of bright fall chinook currently reared at Bonneville. Spring Creek hatcheries will begin a program of rearing bright fall chinook for acclimation and release in John Day pool.

Task 4.2.1(b): Yakima Hatchery

Preliminary investigations by the Fish and Wildlife Service of the Klickitat watershed began in May of 1978. These investigations produced four water sources two of which qualified for the Yakima Hatchery water supply. The Outlet Creek springs, the source finally selected, has a flow of approximately 80 cfs and an average water temperature of 43-45°F. The site contains about nine acres with about four acres available for development.

The hatchery would produce approximately 300,000 pounds of all species of fish annually. Estimated cost of construction is approximately $12,000,000.00 with an estimated yearly operation and maintenance cost of $545,000. The site chosen was selected primarily because of the reliability of the on-site water supply.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of the Yakima Hatchery utilizing power revenues.

Task 4.2.1(c): Umatilla Hatchery Complex

During 1978 and 1979 the Fish and Wildlife Service conducted an Anadromous Fish Enhancement Study on the Umatilla Indian Reservation on behalf of the Confederated Tribes of the Umatilla Indian Reservation. Two sites were identified by the study as the most economically feasible for fish production on the reservation. The study recommended that both the Minthorn Springs hatchery site and the Bonifer Springs site be considered together as a complex, with development potentially occurring in two stages.

The annual production of thehatchery complex should approach 26,000 pounds of salmon and/or steelhead. A single species program was recommended. Total construction costs were estimated at approximately $1,500,000 with yearly operation and maintenance costs at $22,900. The plan envisioned a sharing of equipment between the two sites.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program funding for the construction of the Umatilla Hatchery Complex utilizing power revenues.

Task 4.2.2: Design fish propagation facilities

Introduction: It is expected that numerous hatchery sites will be proposed for immediate construction under Task 4.2.1. Additional hatchery sites will be identified over time and prioritized for construction through the process described in Tasks 4.1.1 and 4.1.3. In addition, expanded use of existing hatcheries will be identified through Task 4.1.2 and proposed for construction through Task 4.2.1. The present discussion, Task 4.2.2 will establish a mechanism to initiate design of facilities that have passed through the identification sequence.

Status: Capability to accomplish design of artificial production facilities varies throughout agencies. The following information was derived from direct communication with fish culture and engineering experts within state and federal agencies.

A. WDF - Don Bartlett

Has engineering capability up to and including total design and construction administration for major facilities. Also has extensive experience with contract design services.

B. ODFW - Ernie Jeffries

Has engineering capabilities up to and including total design and construction administration for major facilities.

C. USFWS - John Hanson

Has engineering capability up to and including total design and construction administration for major facilities.

D. WDG - Jim Gearheard

The Game Department has only a small groups of engineers and design for major facilities would be done by consulting contract.

E. IDFG - John Coon

Has handled most design work through outside contracts. Capability exists to administer design and construction phases.

All project designs should the be the responsibility of the requesting agency or tribe and that each entity secure project designs through either in-house capabilities or contract consulting services, depending on the unique capabilities of the agency or tribe.

All funding should be provided directly to the requesting agency by BPA or other responsible authority for feasibility studies, preliminary design, and final construction documents. Expenditure of design money is to be administered by the requesting agency.

Anticipated Results

The operating agency or tribe will secure a final construction document through in-house services or through consulting contract. The document will include working drawings and specifications and detailed cost estimates showing material, labor, equipment, etc. The document will be of a quality acceptable to be used by the agency or tribe to solicit construction bids.

Scope of Work

Following submission of hatchery site proposals under Task 4.2.1 the design phase would proceed as follows:

A. Power Planning Council or other authority (BPA, PUD's) receive 4.2.1 recommendations including funding proposal for feasibility studies.

B. Power Planning Council obligates funding for feasibility studies to the requesting agency.

C. Requesting agency or tribe completes site feasibility study in-house or through contract consulting services.

1. Elevations
2. Water supply - pumped, gravity, amount
3. Compatibility of site with project
4. Preliminary design and construction cost estimates

D. Requesting agency or tribe proposes funding of design and construction package to BPA, Power Planning Council, or other appropriate authority.

E. Power Planning Council obligates design and construction funds to requesting agency.

F. Requesting agency or tribe develops preliminary and construction designs and construction bid documents.

1. In-house or
2. service contract with agency administration responsibility.

A proposed general guideline for design phases is attached. This guideline has been successfully used by the Washington Department of Fisheries in design and construction of the Washington State Salmon Enhancement Program. The guidelines specify the role of the consulting engineer but the same responsibilities would be held by the project engineer if design was carried out in-house.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program that the design of all hatchery compensation facilities be the responsibility of fishery agencies and tribes and that such design be funded with power revenues.

Attachments

SCOPE OF CONSULTING ENGINEER'S SERVICES

PROJECT

General

The Engineer will be required to maintain complete project records including copies of all correspondence and documentation for payment purposes. All meetings or conversations which provide guidance, verbal directives or transfer of data will be recorded by the Engineer with a copy supplied to the State within one week of the meeting.

The Engineer is responsible for notifying the State of any direction received from the State that is deemed a change of scope of the Engineers services.

PHASE I - PRE-DESIGN AND DESIGN DEVELOPMENT SERVICES

This phase shall begin with the acceptance of the consultant contract and will be complete upon acceptance of the Design Development Documents by the State.

PRE-DESIGN SERVICES

1. Survey existing structures to determine their condition, and made measured drawings of existing construction where required for designing additions or alterations.

2. Obtain soils and topographic data necessary for design and to identify potential construction problems. Special attention shall be given to the use of on site material for pond construction.

3. Locate existing underground piping and obtain data on existing utility services.

4. Determine any special requirements impacting work in the river and connecting to existing construction.

5. Determine the extent and type of clearing required along with clearing methods to be used to prevent erosion.

6. Develop a project schedule from start of design through construction. Bar-graphs will be prepared to indicate design and bidding schedules, and major construction activities.

The Engineer shall make a formal presentation to the State of the data gathered during the pre-design effort prior to commencing work on the Design Development Documents.

DESIGN DEVELOPMENT SERVICES

The Engineer shall prepare for approval by the State, the Design Development Documents consisting of schematic drawings, sketches, and other documents to fix and describe the size and character of the entire project as to structure, mechanical and electrical systems, materials and such other essentials as may be appropriate. Design Development Documents shall include, as a minimum example, four (4) sets of the following:

1. Site plans
2. Floor plan
3. All elevations
4. Structure cross sections
5. Major construction details
6. Basic mechanical systems
7. Basic electrical systems
8. Pond profiles and cross sections
9. Outline specifications describing the materials to be used
10. Preliminary structural, mechanical and electrical design calculations
11. A statement of probable construction cost using budget estimating techniques.

PHASE II - CONSTRUCTION DOCUMENTS SERVICES

This phase will commence with the approval by the State of the Design Development Documents and will be completed upon the State's acceptance of a contract for construction.

1. The Engineer shall prepare working drawings and specifications detailing the requirements for the construction of the entire project including necessary bidding information. These construction documents shall be prepared from the approved Design Development documents to the 90% stage at which time four (4) sets will be submitted to the State for review and approval. The final Construction Documents will be prepared from the approved 90% design. Upon acceptance of the Construction Documents, the Engineer shall deliver to the State the documents for printing and bidding.

2. The Engineer shall assist in preparation of bidding forms and the Conditions of the Contract.

3. The Engineer shall provide two (2) copies of a complete brochure consisting of all of the final design calculations used by the structural, electrical and mechanical engineers for this project and shall submit this brochure with the final design documents.

4. The State will arrange for all approvals from governmental authorities having jurisdiction over the project. The Engineer may be requested to prepare certain exhibits, maps or sketches to be used for permit application.

5. The Engineer shall provide on a bar chart or CPM diagram at least one feasible construction schedule which may be made a part of the construction bid documents and which may be used as the basis of the Construction Contract time.

6. The Engineer shall provide a complete detailed cost estimate showing breakdowns for material, labor, equipment, mobilization, etc.

7. Following the State's approval of the Construction Documents and of the latest Construction Cost Estimate, the State will obtain bids and, upon receipt of an acceptable proposal, prepare Construction Contracts and award the work.

8. The Engineer will receive and respond to questions from prospective bidders, prepare addenda documents, attend pre-bid conferences, and participate in post-bidding negotiations between the State and the successful bidder, all as necessary and requested by the State.

PHASE III - ADMINISTRATION OF THE CONSTRUCTION CONTRACT

The Construction Phase will commence with the award of the Construction Contract and will terminate 60 days after final payment is made by the State to the Contractor.

1. The State shall provide Administration of the Construction Contract as set forth in the general conditions of the Construction Contract. The Engineer shall assist as requested by the State.

2. The Engineer shall provide an individual with appropriate qualifications, and satisfactory to the State, to act as full-time Inspector to monitor the work of the construction contractor during the core period of the construction effort. The duties, responsibilities, and limitations of authority of this inspector will be set forth in detail and appended to the State-Engineer agreement.

3. The Engineer shall conduct a concrete and soils testing program or arrange for an independent testing lab to perform these services, on behalf of the STATE. The Engineer will not conduct technical tests which are to be paid for by the CONTRACTOR.

4. The Engineer shall review and comment on all shop drawings, material submittals, and other submittals required by the contract. The Engineer shall record and distribute properly marked copies, and verify that required changes are actually effected.

5. The Engineer shall receive and process requests from the Contractor for clarifications of the contract documents (including errors or omissions in the documents).

6. The Engineer will receive and verify the Contractor's applications for payment and transmit them to the State for payment.

7. The Engineer shall prepare Change Orders including the issuance of necessary drawings and specifications to describe work to be added, deleted or modified; review Contractor's proposal; conduct negotiations with the Contractor and make recommendations to the State; and secure the State's approval to act on modifications that may affect the utilization of the project, extra cost or additional time.

8. The Engineer shall perform contract close-out services as follows:

   A. Determine by detailed inspection with the State's representative when the project is sufficiently complete to permit occupancy by the State.

   B. Prepare a punch list of items to be completed or corrected, and maintain this list until final completion is secured.

   C. Review warranties, affidavits, and related documents assembled by the Contractor.

   D. Conduct final inspection with the State for final acceptance of the work.

9. The Engineer shall monitor the progress of the construction relative to an established schedule, and report this information to the State weekly.

10. The Engineer shall provide a set of reproducible as-built record drawings.

Task 4.2.3: Construct fish propagation facilities

Introduction: This task write-up will set out a process for construction of compensation facilities. Facilities at the construction stage have previously been sanctioned by the selection system set out in Tasks 4.1.1 through 4.1.3. The facility has been designed through the working drawing phase and a bid package has been assembled. All design activities have been completed under BPA or other funding approved by the Power Planning Council. As outlined in Task 4.2.2 funding for the construction phase was previously secured under the design submissions.

Status: Agencies having potential for construction requests indicated that most would require contract services for construction of any but minor artificial production facilities. Each agency was experienced in administrating service contracts for construction and could be expected to perform this function. Several agencies including ODFW, WDF, and FWS are currently involved in administration of construction under outside contract.

The economic atmosphere is unusually favorable to construction at this point in time and bids are being obtained that are below design cost projections. In keeping with the objective of gaining the best economic use of funds and facilities, it would behoove all agencies to expedite design and construction procedures.

Funding for construction of artificial production facilities would be provided by the power authority whether it be BPA, local utilities, or other authority in keeping with the Section 4(h) provisions of the Power Act. Ideally, funding for construction would have been obligated under Task 4.2.2. If not, funding would be secured prior to solicitation of the construction bid.

Agencies or tribes will independently secure construction bids and administrate construction contracts for artificial production facilities.

Anticipated Results: The agency or tribe would begin the construction phase with a construction document and would, through the process outlined below, receive a construction bid, administrate the construction program, and maintain responsibility for all phases of construction through final acceptance and billing.

Scope of Work: The following process will carry an artificial production facility through the construction phase from solicitation of the construction contract to final payment to the contractor.

1. Agency or tribe secures funding obligation from funding authority (if not secured under 4.2.2).

2. Agency or tribe assigns project engineer.

3. Bids will be solicited by the agency and a construction contract awarded.

4. Contractor will perform construction duties as stipulated in the construction contract.

5. Agency or tribe will provide an inspector and will be responsible for final acceptance documents.

6. Agency or tribe will process contractors' claims for payment and will provide such payment from funds secured from funding authority.

The attached construction phase guidelines are used by the Washington Department of Fisheries and are provided as a detailed list of obligations assumed under construction contracts.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the construction of all hatchery compensation facilities by fishery agencies or tribes utilizing power revenues.

Task: 4.2.4: Operate and maintain hatchery facilities

Introduction: This task write-up will set requirements for funding of operation and maintenance of artificial production facilities constructed under Section 4(h) provision of the Regional Power Act.

Status: It has become common practice for fishery agencies to operate and maintain artificial production facilities and to receive funding for these activities from parties responsible for compensation. An extensive list of funding responsibility for operation of compensation facilities could be developed but is foregone here, in that the premise is well established and, it is assumed, acceptable to all parties.

Funding for operation and maintenance or artificial production facilities constructed to provide compensation under the Power Act should be the responsibility of the compensatory authority. The fishery agency would maintain ownership of the facility and would be responsible for operations and maintenance of that facility, subject to receipt of adequate funds.

Scope of Work: The following provides a simple guideline that could be followed in fulfilling funding and operating obligations and responsibilities:

1. Agency or tribe develops operating budget request for fiscal year and submits to funding authority. (Submittal date to be designated by agreement.)

2. Funding authority obligates funds to operating agency.

3. Agency provides annual reports of activities to funding authority.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program that sufficient operations and maintenance funding of hatchery compensation facilities be transferred annually from power entities to the fishery agency or tribe operating the subject facility.

Task 4.2.5: Changes in Existing Hatchery Operations

Extensive hatchery development occurred during the 1950's and 1960's. Due to decisions of fishery agencies at that time, many of the hatcheries were constructed below presently acknowledged Indian Treaty fishing grounds. These decisions have resulted in tremendous losses to the Indian Treaty fisheries above Bonneville Dam.

By changing some of the release sites to the upper Columbia River system, immediate benefits could occur to Treaty fisheries. These increased runs do not reflect compensation for passage losses.

Recommendation: That the Power Planning Council include in its Fish and Wildlife program the necessary funding to transfer a portion of the fish from lower river production hatcheries to release sites in the upper Columbia River system, in order to assist in meeting Indian Treaty Fishery Rights.

Subobjective 4.3: Determine release sites and levels compatible with natural production and harvest considerations.

Introduction: Subobjectives 4.1 and 4.2 discussed procedures for identifying and selecting hatchery sites by a prioritized system and for designing constructing and operating these facilities under provisions of the Power Act. Subobjective 4.3 will describe objectives and procedures to guide production strategies for artificial production facilities.

Hatchery production within the Columbia River basin had resulted in releases of 159 million anadromous fish of various species in 1976 (1). Extensive enhancement and mitigation efforts resulted in modern day record catches for coastal ocean and Columbia River net fisheries between the mid-1960's and mid-1970's. At the same time fishing rates imposed to harvest available hatchery-produced stocks resulted in over-exploitation of naturally spawning stocks. Additional pressure on wild stocks resulting from passage and habitat losses associated with hydro projects resulted in a decline of stocks, especially spring and fall chinook and steelhead from the Columbia Basin above McNary Dam (2). In response to decreasing escapement the Columbia River net fishery was gradually curtailed to the point that little of the traditional fishery remains. At the same time, the ocean commercial troll fishery and sport fishery continued essentially uncontrolled until 1978 when more restrictive regulations began to be imposed.

Recent court decisions have further highlighted the harvest management problems associated with mixed stock fisheries. Abundant hatchery stocks sustain high exploitation rates while depressed naturally spawning stocks requiring little or no exploitation are overfished. The opposite case provides protection of depressed runs and overescapement of hatchery stocks.

The Section 4(h) provisions of the Power Act supply a vehicle to achieve mitigation and compensation through protection and enhancement. While enjoying the opportunity to restore depressed runs to their previous levels under the auspices of the Power Act, care must be taken to parcel production from enhancement facilities in a manner that will fulfill fishery objectives.

The objective, then, is to develop a program such that production releases from major artificial production facilities are distributed to release sites and at levels compatible with natural production and harvest management considerations.

Discussion and Recommendations: Programs from existing hatcheries include major releases at sites remote from the main rearing station. Off-station plants serve two primary purposes, (1) supplementing natural production in areas of wild production and (2) releasing hatchery fish in areas or in a manner to relieve fishing pressure on wild stocks. The technology clearly exists for diseminating production from a centralized source. It only remains to develop the strategy by which artificial production facilities provided under the Power Act will be operated to meet stated objectives of restoring run sizes and fishery levels consistent with natural production and harvest requirements.

A release strategy working group will be assigned by agency and tribal authorities. The group will submit a funding proposal to BPA to secure funds to develop production and release strategies to be applied to artificial production facilities constructed and operated under Section 4(h) provisions. To achieve the objective the working group will:

1. Submit funding proposal to BPA.

2. Determine desired regional production levels by species (i.e., McNary Dam to Priest Rapids fall chinook production) within limits discussed in Chapter G.

3. Determine necessary fishery effort distribution and contribution including opportunity for terminal area fisheries.

4. Determine levels of augmentation of natural stocks necessary to sustain fishing rates and compensate for passage losses.

5. Identify available planting or rearing-release sites compatible with required augmentation levels.

6. Identify level of support required at each site.

A. Fry-fingerling plants

(1) natural carrying capacity for juveniles

(a) low flow limitations
(b) forage
(c) other limitors

B. Migrant smolt plants

C. Feeding and imprinting stations

7. Implement strategies by interaction with artificial production development under subobjectives 4.1 (task 4.1.3), 4.2 (task 4.2.1), 4.5 and 4.6 (task 4.6.1).

Requirements 1, 2, and 3, have been addressed at some length by the agencies and tribes. Requirement 5 would be a potential product of research under task 4.6.1 and results from that task should be adopted under this subobjective. Requirement 4 would be achieved directly by the working group.

It is clear that accomplishment of Subobjective 4.3 is closely intertwined with development of information, results of research, and progress within complementary tasks and subobjectives. This working group should, however, have an active role in providing production related requirements and their input should be included in proposals for artificial production facilities.

Recommendations: That the Power Planning Council include in its Fish and Wildlife Program development of a hatchery release strategy program to assure optimal benefit from compensation production.

Subobjective 4.4: Provide for increased efficiency and improve the quality of fish produced at hatchery facilities operated as compensation for hydroelectric development.

Task 4.4.1: Determine the most efficient single or multiple species rearing program at existing hatchery facilities for contribution to the fisheries and escapement

Introduction: The successs of hatcheries is dependent, in part, on the optimum utilization of rearing space and wter for the production of high quality smolts. Potential increases in hatchery contribution can probably be achieved at various existing compensation facilities by optimizing the smolt output from the hatcheries. Existing compensation facilities need to be evaluated to determine (1) if the species and species mix being reared are compatible with the water supply and physical facilities and (2) what potential exists for increasing the hatchery's contribution by changing the species, number of fish reared, and species ratio.

Physical plant inadequacies could be ldimiting smolt production and quality at certain hatcheries. For example, a station rearing fall chinook and coho might be relesing a part or all of their coho early to make pond space available for fall chinook that needed to be moved out of the hatchery building tanks. This practice could result in a low return of coho. In thic case, a solution to the problem might be achieved by adding pond space or changing the species composition at the station. Mumerous other such examples could be cited.

The evaluation of species and species mix at existing compensation hatcheries could result in changes in production programs which would increase station efficiencies and improve smolt quality and survival.

Current Status: Most of the past and current effort to optimize hatchery production and evaluate the species mix at various facilities has been done by the Washington Department of Fisheries. They have developed a hatchery

computer model which is used to optimize hatchery systems and develop the best, most cost-effective species mix. The model has been used on Puget Sound hatcheries and will soon be ready to use on Columbia River stations. This could be a useful tool for optimizing production at all compensation facilities.

A small group of fishery experts with extensive expertise in fish culture should be designated to evaluate the efficiency and smolt output from each compensation facility. An onsite visit to each hatchery should be made. The task group should look at the species being reared, number of fish, and the relationship between the species mix and the adequacy of rearing facilities, and the relationship between species and the quality and survival of smolts.

Results Expected: A comprehensive evaluation of the species mix at existing compensation hatcheries could very well result in changes in production programs which would increase station efficiencies and improve smolt quality and survival.

Scope of Work: The following actions are needed to accomplish the task outlined:

1. Select a group to do the work. Whoever is selected should have broad expertise in fish culture.

2. Obtain information from the agency operating the compensation facility on:

   A. the present species mix - why is it being used;

   B. the present quality of smolts;

   C. the survival of smolts and contribution to the fishery and escapement;

   D. the adequacy of the water supply and rearing facilities;

E. fish health problems, and

F. ability to meet present mitigation requirements.

3. Evaluate information and develop a set of recommendations for increasing the hatchery's contribution by changing the species mix or correcting physical problems with the plant. This should be in the form of a report.

4. Implement recommendations made in report.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program an evaluation, utilizing power revenues, of existing and future hatchery compensation facilities to determine the most efficient rearing programs.

Task 4.4.2: Adopt stock assessment evaluation system for columbia Basin

Introduction: There has been a lack of recognition of the part of harvest managers and others that individual hatchery stocks are unique and underescapement at a particular facility is a serious problem. The tendency has been to look at hatchery runs as a pool of eggs and if one hatchery has a surplus and another a deficit of eggs, there is no problem. This view reflects a complete disregard and lack of understanding of the stock concept and the importance of strain differences. Fish propagation specialists have long been aware of the problems associated with stock transfers. They realize improper brood stock selection can lead to failure and that screening of stocks is imperative.

Presently, compensation facilities rearing salmonids may not be utilizing a stock which (1) survives well in the particular hatchery environment it is being reared in, (2) meets in-place mitigation requirements, (3) meets in-kind mitigation requirements, (4) contributes well to ocean and river fisheries, and (5) imprints and homes well it its native stream. Existing compensation hatchery stocks need to be reviewed and evaluated to ensure they meet these criteria. In addition, various stocks should be assessed as to their suitability for use at new facilities being planned or those coming on line in the near future.

Current Status: There has been no systematic assessment of hatchery stocks in the past to determine their suitability for present or future rearing programs. Rather it appears each agency has utilized stocks largely on the basis of their availability, disease history and migration characteristics. This has worked to a degree, but certainly a careful review of stocks would have additional payoffs in terms of onsite hatchery operations and contribution to the fisheries.

Most fishery agencies have been heavily involved in an ongoing program of evaluating present hatchery stocks and their contribution. Included in these evaluations have been the performance of stocks transferred to new

hatchery locations. A great deal of published and unpublished information on these evaluations exist which, if brought together and summarized, would provide a nucleus of data for a stock assessment program.

Needed Action: The priority action required in setting up a stock assessment program for Columbia River compensation hatcheries is to document all the pertinent facts about the known anadromous stocks in the basin. This assessment should include the following:

1. Species, strain or stock;

2. Present and historical geographical range; hatcheries presently utilizing stock;

3. Timing of run;

4. Disease history; susceptibility to diseases;

5. Availability of stock (i.e., are adequate numbers of eggs available annually to meet production needs);

6. Migration characteristics;

7. Survival and contribution;

8. Age and size composition (smolt and adult, original and present).

Where questions arise as to the genetic uniqueness of a stock, research should be done, utilizing electrophoresis and other tools, to verify whether a race of fish is in fact unique. Also, in cases where populations have dwindled and information is lacking on actual population size, field studies should be conducted to determine population estimates.

Once all the facts on existing stocks have been documented and summarized, this information should be made available to agency fishery administrators responsible for fish culture programs in the Columbia Basin.

They can use this information to make decisions on stock selection which will best serve their needs and the needs of the fishery.

Results Expected: Implementation of a stock assessment program in the Columbia Basin could result in improved survival of fish within the hatchery and following release; preservation of the genetic integrity of stocks; assurance of in-kind mitigation; improvement in quality of marketed fish.

Scope of Work:

The scope of work involved in developing a uniform stock assessment program for Columbia River compensation facilities includes:

1. gathering data on existing stocks including all information itemized under the needed action section;

2. conducting research to determine genetic variations between certain races whose genetic makeup is in question;

3. conducting field studies to determine population size of depressed stocks where this information is lacking;

4. summarizing all data in a stock assessment report;

5. disseminating report to fishery administrators for use in stock selection decisions.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program a fish stock assessment program funded by power revenues to assure proper use in compensation facilities.

Task 4.4.3: Adopt improved fish disease diagnostic systems and control of fish diseases Basin-wide.

Introduction: Traditionally, fish diagnostics and control measures have been carried out at individual hatcheries. Most of the diagnostic systems and protocol have been formulated at research labs in Seattle, Washington (FWS, Leetown, West Virginia (FWS), Corvallis, Oregon (ODFW), and Moscow, Idaho (University of Idaho). There has not been any fish health policy developed for any of the Northwest basins similar to the Colorado River and Great Lakes policies.

Current Status: There is a serious need for some type of systematic approach to surveying and cataloging fish pathogens in Northwest waters. Agencies must convene to have their fish health diagnostic techniques (i.e., sampling frequency and methods) standardized. The conduct of investigations in a similar manner and time frame to optimize sharing sharing this information and using it wisely.

Research must continue to work on rapid diagnostic tools such as the Enzyme Linked Immunosorbent Assay (ELISA) which could reduce bacterial detection from hours to minutes and viral testing from weeks to minutes. The research labs should be encouraged with staff and funds to provide these advance techniques for the field hatchery biologists. More rapid diagnosis and control fish diseases should greatly improve hatchery contributions to the ocean and inriver fisheries.

Scope of Work:

1. Determine impact of present diseases on fishery resources.

2. Map out ranges of fish pathogens in the Pacific Northwest.

3. Develop standardized techniques for fish pathogen detection.

4. Find control measures for BKD and Saprolegnia sp.

5. Provide background data and pursue registration of necessary drugs for pathogen control or elimination.

6. Develop a stock transfer policy based on the pathogens and their virulence.

7. Develop a Basin coordination committee for fish health.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the need for improved fish disease diagnosis and control to allow increased production at compensation hatcheries.

Task 4.4.4: Adopt a system to determine smolt quality and readiness to migrate for compensation hatchery stock

Introduction: Fish culturists have extensively studies methods of determining smolt quality and readiness to migrate. Nonetheless, definitive hatchery techniques are not available and more work is needed. Guidelines must be developed to measure smolt quality. If a series of tests could be developed which would indicate when a given group of smolts would be the most competent to enter and survive salt water, our hatcheries could run at their maximum efficiency. Parameters should be set up for each geographical area and species to determine the relative quality of a smolt.

Current Status: Fisheries biologists and culturists have utilized the return to the fishery and hatchery as a means of evaluating hatchery techniques. The evaluation of a hatchery program involves cost, numbers released, and percentage return; therefore guidelines to manage for maximum benefit.

Physiological studies have been conducted in the past decade that show promise; ATPase studies on the lower Columbia, blood sodium work by the Seattle National Fisheries Research Center, and thyroid hormone relationship to smoltification in Oregon. Behavior work is sparse probably due to the amount of time spent on the above physiology.

Physiologists, fish biologists, and others who are trying to develop indices for smolt readiness should summarize their information by species and define needed work.

We know that the environment for anadromous fish will be changing and our releases of fish will have to change with it, so we need to know the optimum time, size, and place to realize the maximum yield. If we could define a quality smolt and determine timing of the smolts maximum chance for survival, the above objectives could be met. It must be determined how environmental factors work with or against the physio-biological processes of a smolt.

Results Expected: Fish culturists could be directed by environmental conditions (e.g. drought, high water, and elevated temperatures) for their releases. In the past, fish were planted at a given size and time. With a Smolt Quality Index and Smolt Release System, we could release fish knowing that we have provided the optimum environmental conditions prior to entering the ocean.

Scope of Work:

1. Select a group of both fish culturists and physiologists.

2. Conduct comprehensive literature search on past and ongoing studies with Smolt Quality Indices and Smolt Release Systems.

3. Develop specific criteria from an evaluation of current ongoing physiological work with Smolt Quality Indices and Smolt Readiness. We would be able to define:

    A. Smolt Quality

        1. Criteria to use.

        2. Methods of assessment.

    B. Smolt Competence

        1. What can be manipulated without affecting it.

4. Select a specific area and species to evaluate the Index and System. Give a range maximum yield that might be expected and text the hypothesis.

5. Look at and develop recommendation on hatchery practices that may affect smolt survival.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program continued research to determine smolt quality and migration timing for optimizing the productivity of compensation hatcheries.

Subobjective 4.5: Provide for investigation and implementation of capital decentralized artificial production facilities.

Low capital salmon production facilities (LCSP facilities) offer an alternative to the conventional hatchery in cases where large capital resources are unavailable, where large, suitable water supplies are not present, and where the maintenance of a diverse gene pool is desired. Such circumstances are becoming more and more widespread, particularly in the Columbia River Basin.

LCSP facilities are characterized by modular construction using, in many cases, existing components adapted to specific needs. Concrete ponds and raceways seen at conventional hatcheries are replaced by wood or fiberglass construction, plastic swimming pools or other relatively low-cost components. Buildings, when present, usually consist of low-cost shelter-type structures. This type of construction allows considerable flexibility in design to accommodate site-specific problems or other individual requirements. Similarly, future modifications are relatively inexpensive compared to the conventional facility.

Water source for an LCSP facility is, ideally, a spring with sufficient head to supply the needs of the hatchery without the need of pumps. This greatly reduces power costs and eliminates the reliability problems associated with pumped water.

While production from an individual LCSP facility is generally much smaller than that from a conventional hatchery, the greatly reduced cost of each facility allows many to be built for, in many cases, less than a single large centralized facility. The advantages to this are twofold: First, in many localities, particularly the mid- and upper-Columbia River Basin, water sources of sufficient size and quality to support a large centralized hatchery are unavailable (Anon. 1981). Smaller, scattered water sources are often available, however, which could be utilized by LCSP facilities.

Secondly, centralized hatchery facilities often replace or supplement natural production from several salmonid producing systems with a single large production center. This results in a "homogenized" population where formerly existed a heterogeneous gene pool composed of genotypes adapted to specific conditions of individual environments. This trend is exacerbated by the common practice of exchanging fish or eggs between centralized facilities to adjust for variable returns. In recent years, biologists have begun to realize that preservation of diverse gene pools is advantageous in terms of overall fitness and production of quality adult returns (Helle, 1976). Decentralized LCSP hatcheries can be built on a number of tributaries rather than using a single centralized facility. By utilizing native brood stock and not exchanging fish and eggs between facilities, a more diverse gene pool is realized than would result from the large, central facility. While LCSP facilities may not be able to maintain the total genetic diversity present in a wild spawning population, they would provide a good compromise between natural production and centralized artificial production facilities. LCSP facilities are a viable alternative, particularly in those areas requiring compensation due to permanent habitat loss or other factors

LCSP facilities cannot, however, be regarded as a panacea to solve the problems associated with hatcheries, or as a substitute for wild production. Large conventional hatcheries have their place in producing large numbers of fish. Indeed, much of the present salmonid production in the Columbia River is the result of this type of facility, which testifies to their success. Although proper placement and utilization of LCSP facilities can result in an increased genetic diversity as compared to conventional hatcheries, they still result in fish adapted to the hatchery environment, and cannot replace wild production. In addition, the problems associated with differential allowable harvest rates between hatchery and wild populations still exist with LCSP hatcheries. Operation of such facilities would, however, lend themselves better to obtaining a diverse brood stock each year, thereby replicating the natural situation better than past operations at larger hatcheries. When enhancement is deemed to be required, LCSP facilities will often prove to be cost effective as compared to conventional hatcheries due to reduced cost and the ability to utilize smaller water sources.

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Task 4.5.1: Develop systems for small production facilities

Development of a system for low-capital salmonid production (LCSP) in the Columbia Basin will require adaptation of existing designs and technology to specific local problems and environments. LCSP facilities address the need for compensation in areas having small scattered water supplies not adequate for conventional hatchery development, where preservation of genetic integrity is desired in an enhancement situation, and where large capital investment is unavoidable.

LCSP facilities are a relatively recent phenomena brought on primarily by development of enhancement programs by groups with limited capital resources. These groups include Indian tribes, fishermen's cooperatives (primarily in Southeast Alaska), and small-scale private aquaculture. By their very nature LCSP facilities do not conform to any standard form; each facility is designed to meet the requirements of the site and the resources of the builders. LCSP facility development has been a kind of "cottage industry" and very few designs or techniques have been published.

Probably the greatest use of LCSP facilities has been the fisheries programs of Indian tribes in Puget Sound and the Washington Coast. These facilities display a wide range of designs and sophistication, and have proven extremely successful. Although many of the features of these facilities may be applicable to development of LCSP facilities in the Columbia Basin, development of designs appropriate to sites and the environment in the Columbia Basin will be necessary. In addition, while complete standardization is neither possible nor desired, some standardization of the general design and ready access to existing designs and technology will be beneficial.

Needed Research: Study of LCSP facility development will require completion of the following tasks, aimed at assembling available information on designs and technology, and development of a generalized design which can be adopted to specific sites and situations:

1. Application of existing LCSP designs to compensation situations in the Columbia Basin.

This task will involve showing how use of LCSP facilities presently in use by Indian tribes, private aquaculture, and others can be used to solve specific compensatory needs in the Columbia Basin. The task should include, but not be limited to, the following:

A. Low, and possibly variable, volume water supplies.

B. Applicability to areas east of the Cascade Range encountering relatively severe winter and summer temperatures.

C. Producing sufficient releases to provide for the fisheries, to supplement natural production, and for egg-taking in the face of inter-dam and other environmental losses.

2. Compilation of existing technology applicable to LCSP development.

A primary feature of LCSP facilities is the use of existing technology, much of it designed for other purposes, to replace high-cost custom construction. A major problem encountered is that much of this technology is scattered, and required extensive time and effort expenditures to find what is available. It will be the goal of this task to compile a listing of supplies and equipment appropriate to LCSP development. In addition to an independent search for appropriate suppliers and technology, current users of LCSP facilities should be consulted.

3. Engineering study to develop a generalized LCSP facility for the Columbia Basin.

LCSP development is not generally amenable to a standardized design, being instead characteristically flexible to accommodate variability in sites, goals, and resources. However, some degree of standardization to provide guidelines and recommendations for LCSP

facility development is desirable. In addition, many existing LCSP facilities operate in the relatively benign environment west of the Cascade Range. Some design modification and development will be required to accommodate existing designs to the harsher conditions in much of the mid- and upper-Columbia Basin.

The goal of the task is to develop a generalized LCSP hatchery and to provide engineering guidelines for LCSP hatcheries in the Columbia Basin consistent with the following reuqirements:

A. Flexibility in design to allow accommodation to various sites and to permit future modification at relatively low cost.

B. Water supplied, ideally, by gravity feed from spring source, although flexibility in design to accommodate other water sources is required.

C. Enhancement will be primarily directed at chinook, coho, sockeye, and steelhead.

D. Low capital cost.

E. Construction will minimize the use of concrete or other permanent structure in favor of wood, fiberglass, pre-formed components or other relatively low-cost construction.

F. Design(s) must be applicable to environmental conditions in Columbia Basin.

G. Operation and maintenance costs should be minimized.

[illegible] and evaluation of prototype LCSP facilities.

Following or concurrent to satisfying the three other objectives, [illegible] LCSP facilities should be installed and put into

production to evaluate their biological feasibility and cost effectiveness.

Tribal reservations and ceded areas in the Columbia Basin contain hundreds of miles of rivers, lakes and streams suitable for productin of anadromous salmonids . Due to diminished returns of adult spawners to these areas, much of this habitat remains under-utilized. Increased production in these areas by using at the outset, low-capital artificial production techniques, would contribute toward alleviating fishery-related problems throughout the system.

Recommendations: That the Power Planning Council include in its Fish and Wildlife Program the development of low-capital salmon production facilities funded by power revenues for immediate application to fish compensatory needs caused by hydroelectric development and operation.

Task: 4.5.2: Low Capital rearing facilities on the Nez Perce Reservation

The Nez Perce Tribe of Idaho wishes to determine the potential of low technology (cost) artificial production of spring chinook salmon and steelhead within the reservation. As outlined in our proposal entitled "Low Technology Fisheries Facilities for the Enhancement of Anadromous Salmonid Stocks on the Nez Perce Reservation," we recommend that Phase I (Reconnaissance Studies) be initially funded with the understanding that Phase II (Preliminary Design) and Phase III (Final Design, Construction, and Operation) will eventually be funded upon development of the proper information based on the preceding phases.

Because of the depressed nature of the runs of anadromous salmonids to the Idaho headwaters very little natural production is presently occurring in streams within the Nez Perce Reservation. Historically, however, considerable anadromous salmonid production occurred within the reservation boundaries. Because of the large size of the reservation, 756,000 acres, and the abundant surface water supply (over 300 miles of rivers and streams) it is hoped that quality low-cost artificial) production sites will be identified. An increase in anadromous salmonid production through low-cost artificial production methodologies in the headwater areas of the Columbia River Basin (i.e. Nez Perce Reservation in Idaho) would benefit both Indian and non-Indian fisheries in the mainstem Columbia, Snake, and Clearwater Rivers.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the investigation and construction of low-capital fish production facilities on the Nez Perce Indian Reservation in Idaho.

CH2M HILL
engineers
planners
economists
scientists

November 1, 1981

B491.64

Mr. James Johnson
Fisheries Program Director
Nez Perce of Idaho
P.O. Box 365
Lapwai, Idaho 83540

Dear Jim:

Subject: Low Technology Fisheries Facility Proposal

Enclosed, please find five (5) copies of the proposal we have prepared for the Nez Perce to submit to the Pacific Northwest Electric Power and Conservation Planning Council. Please feel free to reorganize the proposal as you see fit. I borrowed the background information from your BPA proposal, which appeared to be suitable for this one as well.

If the planning council wants to know who your consultant will be, CH2M HILL will be glad to forward our SOQ to them or you can send along your copy to Al Kendel. We believe that the Phase I cost proposal will be adequate to give the Nez Perce the stated work products. Cost of Phase II and Phase III will be developed on completion of the preceding phase.

If you need more information or have any questions, please give me a call. Otherwise, good luck, and I hope we hear from you soon.

Sincerely,

Mark T. Hill

Mark T. Hill
Fisheries Scientist

E319-A/sw

Enclosures

Subobjective 4.6: **Investigate the feasibility of supplementing natural production with hatchery outplants.**

Maintaining or increasing wild populations of salmon and steelhead in the uppermost Columbia and Snake River basins would be difficult without hatchery supplementation due to the combined effects of exposure to the full hydropower system and mixed stock fisheries.

The current inter-dam loss of both migrating smolts and adults has raised serious doubt whether the naturally produced salmon resource can be maintained as a viable entity and still make any significant contribution to the resource's harvest potential. Regardless of the freshwater habitats' potential to produce juveniles or protective measures adopted to return adults to the Columbia River, the inriver juvenile and adult loss is such that it has all but displaced totally any significant sustained yield from the naturally produced resource originating above McNary Dam. Therefore, it is becoming increasingly apparent that there is an immediate need to recognize this problem and develop a comprehensive plan which draws upon a well-planned natural production supplementation program. This natural production supplementation would occur through a well-planned hatchery program designed to address current, natural production and harvest constraints.

Natural production is currently being depressed, in part, due to lack of juvenile production relative to available rearing habitat and inter-dam loss of smolts. Harvest is being constrained in ares below Bonneville Dam due to need to provide court determined allocation. Fishery above Bonneville Dam is constrained due to depressed status of natural production compound by significant inter-dam loss of adults. A well-planned hatchery program to supplement natural production can compensate for the production loss problem and, thus, go a long way toward reducing the harvest management problems.

Thus, any future hatchery program planning should be directed toward releasing enough smolts (1) to supplement juvenile production by off-station releases of the proper brood stock into natural rearing habitat which did not receive sufficient seeding, and (2) to compensate for inter-dam smolt loss. If

the artificial production facility was properly sited or managed, returning adult production or off-station plants would contribute both to the natural spawning population as well as the future hatchery brood stock. In turn, the hatchery production could be maintained as close to the natural stock as possible by obtaining brood stock in part from voluntary returns to the hatchery and in part from the natural spawning population.

Natural runs of salmon and steelhead below McNary dam are less seriously impacted by the dams and it should be possible to maintain some of these runs in the long-term without hatchery supplementation. Hatchery supplementation is required in many of the areas below Bonneville Dam because the harvest rate on these fish is generally dictated by the strength of the hatchery return. This results in an over-harvest of natural production. Care should also be taken to protect the Hanford stocks of fall chinook and preserve the genetic characteristics of this sock.

While this subobjective might typically be undertaken by fishery entity funding, the increase of hatchery production as compensation for hydroelectric development has placed increasing burdens on the management of natural stocks. Resolution of the problems caused by these conflicts and increased complexity must therefore be a burden of the hydroelectric system.

Task 4.6.1: Determine means and degree of integrating artificial and natural production to optimize use of natural habitat and escapement.

Research and development of means and degrees of integrating artificial and natural production are required to optimize use of natural habitat and escapement. Two situations in the Columbia Basin lead to the need to supplement natural production areas with carefully planned releases of artificially produced fish.

Most salmon runs destined for tributaries of the Columbia River below Bonneville Dam are regulated by the management authorities on the basis of hatchery run strength. Hatchery production may typically be harvested at a much higher rate than natural production. Oregon Department of Fish and Wildlife (1981) estimates that each natural spawning female coho will produce 6 adults. This same female coho, under a full term hatchery rearing program, will produce an average of 44 adults. Only 4 of the wild fish may be harvested and still return the spawning population of 1 female and 1 male. On the other hand, a harvest of 42 hatchery fish is possible and still replace the original seed. All salmon and steelhead follow similar natural and artificial production differences.

Management agencies, in the face of these differential production rates are presented with basically two scenarios. If the regulations are geared to crop the harvestable excess of hatchery returns, the intermingled natural stocks are over-harvested. In the instances where the harvest is set to crop the natural production, a large excess of fish escapes to the hatchery. These problems may be at lest partially overcome by known stock fisheries (located in areas where fish are fairly well separated into groups of known origin) and by supplemental planting of suitable hatchery stocks into the natural production area.

The second situation where supplementing natural production with suitable artificial stocks exists in varying degrees where non-fishery mortalities are inflicted during migration. For example, 13 percent mortality

per project, accumulated through eight projects on the seaward journey, results in a total loss of 67 percent by the time the migrants reach the Columbia River below Bonneville Dam. As a direct consequence of this accumulated mortality, it becomes obvious that natural production from Snake River tributaries, as well as the upper Columbia River tributaries may never, on their own, support the level of harvest formerly provided by these areas. A high proportion of the fish which once entered the tribal, sport, and commercial fisheries of the Columbia River Basin and the Pacific Ocean will continue to be denied to the fishery through this mortality of migrants.

Extensive compensation in the form of hatchery production will be required for the losses associated with the Columbia River hydro complex. Much of this production should be used to maintain a high level of natural production through supplemental hatchery releases. This will require particular care in the selection of stocks to be used, numbers and stage to be planted, and areas to be stocked. Research to determine these needs must be undertaken promptly.

There are several ways in which artificial production can be used to assure maximum productivity of natural rearing areas. Included in these are:

(1) egg incubation boxes or channels
(2) fry or fingerling plants
(3) smolt releases
(4) transportation of maturing adults from hatchery stations to natural production areas
(5) allowing adults produced at hatcheries to reproduce naturally in the local spawning areas
(6) annual selection of mixed natural/hatchery brood stock for artificial production.

Egg incubation systems have been used with varying degrees of success on most species of Pacific salmon. The most notable example of their use in the Columbia River system occurred in the 1960's in the Clearwater River system in Idaho. Spring and summer chinook were successfully produced in incubation channels in the Selway River. Adult returns were encouraging

until migrant losses in the lower Snake River dams began to offset these gains (Terry Holubetz, pers. comm.). These systems are most practical where there is either no or only limited competition with existing natural production in the stream. Harsh weather conditions in many of the headwater areas may limit the practicality of this method.

Fry and fingerling plants can also be used to supplement natural production. Such plants, unless carefully planned, can seriously impact the native stock through competition for rearing area.

Smolt plants provide the least competition with the naturally produced populations. Low capital satellite rearing ponds located in key production areas offer the best solution for spreading smolt plants through the tributary system. This avoids the adverse handling and trucking of smoltified juveniles and provides the best opportunity for overall success.

Transportation of adults, surplus to egg take needs, has been used with varying success with coho and chinook in the lower Columbia tributaries. Washington Department of Fisheries has successfully increased natural spawning levels of fall chinook in the Cowlitz River by transporting maturing fish collected at Cowlitz Hatchery back downstream for release (Phinney, 1976). Oregon Department of Fish and Wildlife conducted extensive transportation of surplus hatchery coho adults to under-utilized and unutilized streams. They have concluded from these operations that while some biological success is possible with this technique, economic factors (cost of hauling) reduce its effectiveness. Fry plants, at much less cots, accomplished the same goals. This method, however, may have certain applications under come conditions, as well as with other species.

Location of a hatchery frequently influences the success of attracting all of its returning adults back into the facility. Hatchery produced fall chinook will commonly spawn naturally if suitable spawning area exists below or in the vicinity of the hatchery. Washington Department of Fisheries mark sampling programs on such spawning grounds show this to occur in the Hanford Reach of the Columbia below Priest Rapids Hatchery, in the Cowlitz River below Cowlitz Hatchery, in the Lewis River above and below Lewis River Hatchery,

as well as all other areas with suitable spawning grounds. The degree of natural spawning can be altered by changes in attraction flow at the hatchery.

Programs are presently underway, primarily in the Columbia River tributaries below Bonneville Dam, to supplement natural salmon production with artificially produced fish either through off-station plants, as well as through natural spawning of hatchery returns (planned or unplanned). Such activities have been extended to the upper river tributaries, but on a limited basis only. This limitation is primarily the result of an insufficient number of eggs or fry of suitable stock. Virtually every available egg in the upper Columbia River has gon toward fulfilling rearing program needs. This will continue to be the case until hatchery brood stocks are fully devloped.

There clearly exists a need to fully develop and implement natural production supplementation techniques. Research is required, and in some instances already planned or underway, which will lead the fisheries agencies into a carefully considered program for increasing natural production through off-station use of hatchery production. This will provide partial compensation for losses incurred through the construction and operation of the Columbia River hydroelectric system.

Questions which must be examined prior to implemention such programs basin-wide include:

(1) What stocks and species are suitable for planting in natural production systems in various areas of the basin.

(2) In what areas have the native runs declined to a "point of no return?" Runs in such areas could possibly be re-established through introduction on non-indigenous stocks.

(3) What planting rates are required, by species and area, to maximize use of natural production areas?

(4) At what stage (egg, fingerling, smolt, adult) should supplementation occur to minimize impact on native or naturally rearing stocks? and

(5) What are the harvest management implications, by stock and area?

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program research funded by power revenues to determine the best manner to supplement natural and stocks with hatchery fish, particularly in the upper Snake and Columbia rivers, to increase natural stocks.

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Task 4.6.2: Maintain wild production of spring chinook in the Willamette River by developing maximum utilization of remaining rearing areas through releases of hatchery spawned juveniles.

Introduction: Construction of high dams in the Northwest has frequently removed vast areas of spawning and rearing stream from the access of anadromous fish. Most frequently mitigation for these lost production areas has been effected by artificial production. Often this has not been effective in replacing the numbers of fish lost. In other cases, fish numbers are replaced or even enhanced. However, the replacement efforts substitute hatchery fish for wild fish. Continued harvest on the replacement fish is most often based on numbers available to crop. Hatchery stocks are able to sustain a higher harvest rate than wild stocks due to high survival from egg to smolts. The eventual result is that dwindling stocks of wild-reared fish continue to be further reduced through continued heavy harvest in the fisheries. Thus, areas still capable of supporting wild-reared salmonids become chronically under-seeded as a result of under-escapement of wild spawners.

One way to restore wild-rearing populations of anadromous fish to under-seeded stream areas is to stock pre-smolt fish from hatcheries into these waters. Released juveniles capable of competing in the natural environment will survive, emigrate, and provide adult returns destined for the available spawning areas, rather than hatcheries.

Current Status: An aggressive program of pre-smolt release is currently underway with coho in Oregon's coastal streams that suffer from over-harvest of wild adults in offshore fisheries. This work is being evaluated through the "STEP" Program (Dick Herrig, ODFW, in progress).

The Willamette system may profit from introduction of pre-smolts. For example, the run of adult spring chinook salmon is estimated to be 2/3 to 3/4 hatchery fish. These fish are intensively harvested in the ocean, lower Columbia, and Willamette River fisheries. Improvement in production of

hatchery-reared fish are geared to doubling the current return of spring chinook by 1985 to meet compensation requirements along with commensurate anticipated increases in harvest levels (Willamette Basin Fish Management Plan, 1980, ODFW, Portland, OR.).

While returns of hatchery fish may increase markedly, indications of wild spawning of spring chinook in the Willamette Basin continue to decline. The McKenzie River is regarded as the major wild-spawning stream in the basin. In 1958-59, about 11,000 spring chinook per year ascended Leaburg Dam to spawn in the upper McKenzie River. From 1970 to 1980, counts of spring chinook over Leaburg Dam averaged 2,540 per year (1980, Willamette River Spring Chinook Salmon Run, Melvin D. Collins, ODFW, Clackamas, OR.).

Needed Research: Stream areas in the Willamette that are chronically under-seeded with wild-rearing fish must be identified. Where introduction appears suitable, experimental groups of pre-smolts should be introduced and survival, emigration, and adult contribution evaluated. Where positive results occur, sufficient extended studies should be pursued to develop recommendations for suitable stocking densities relative to effects of impacts on resident fish species and increasing wild adult escapements.

Results: Expected results will include:

1. Effective use of presently underutilized available rearing areas.

2. Total increase in recruitment of fish.

3. Increased production of wild-reared fish which will improve escapement of adults destined to spawn in the wild. Present estimated increase in wild spawned adult spring chinook returning to the Willamette above Willamette Falls would be 8,000 for a total annual economic benefit to fisheries of $3,374,000. Annual minimum operating cost to Bonneville Power Administration rate payers to replace this last segment of the spring chinook run in the Willamette would be approximately $450,000 in FY 83.

Scope of Work:

1. Identify currently under-seeded stream areas.

2. Collect background data on existing fish population parameters for enough years to derive statistically valid wild production levels.

3. Introduce experimental populations of distinctly-marked sub-smolt spring chinook (200/lb.) in selected stream areas.

4. Monitor chinook rearing (distribution, density, growth), emigration (Willamette Falls emigrant sampler), and adult contribution (fisheries catches, adult passage at Willamette Falls, spawning surveys).

5. Compare resident fish population parameters, pre- v. post-introduction.

6. Monitor adult spawning populations over at least 4 generations of returns.

7. Recommend stocking densities for pre-smolts commensurate with resident fish and wild spawning concerns.

8. Using data derived in the study areas, recommend pre-smolt stocking densities for main tributaries.

Recommendations: That the Power Planning Council include in its Fish and Wildlife Program studies on the supplementation of wild spring chinook with hatchery pre-smolts in the Willamette Basin to increase total salmon production.

Task 4.6.3: Adopt hatchery practices which allow known stock fisheries.

The need for known stock fisheries has long been recognized in the Columbia River and elsewhere in the Pacific Coast salmon fisheries. This need becomes particularly critical in times and areas where a given population of fish consists of a mixture of healthy and depressed stocks. In the last several years, known stock fisheries have been conducted in the lower Columbia River in order to harvest hatchery returns of chinook and coho while, at the same time, affording protection to depressed upriver runs of chinook and steelhead.

There are several considerations which must be kept in mind in the planning and implementation of known stock fisheries. First, these fisheries, where isolated by area, are seldom totally free of some level of abundance of the stock requiring protection. Such fisheries are frequently confined to non-traditional areas and conducted in a non-traditional manner. As such, they have not been particularly popular among the commercial fishery clientele. Such sport fisheries tend to be crowded with decreased aesthetic value to some of the participants.

Known stock fisheries need not be isolated, in all instances, by areas. Separation by run-timing differences may be equally as valuable for the protection of depressed stocks. Additionally, this overcomes several of the objections listed above to the separation by area restrictions. Total separation by time, as by area, is not likely.

While the concept of know stock fisheries frequently is opposed by the user groups, there is little question that the total harvest of fish can be increased with this management tool.

A team of fishery and hatchery specialists from agencies and tribes with fishery management responsibilities should be assembled to develop an implementation plan for further development and refinement of known stock fisheries. This implementation plan must carefully consider the concerns of Indian, sport, and commercial interests.

Among the items which must be addressed are:

1. Feasible locations of known stock fisheries (certainly not be limited to the lower river areas).

2. Hatchery techniques suitable for enhancing known stock fisheries.

   A. Changes in planting location.

   B. Selection of stocks with timing differences which provide separation from stocks which cannot withstand additional fishing pressure.

3. Impact of known stock fisheries on non-target stocks.

4. Harvest management implications, including adaptability and acceptance by tribal, sport, and commercial fisheries.

Recommendations: That the Power Planning Council include in its Fish and Wildlife Program the development of an implementation plan to develop the use of some hatchery fish for known stock fisheries. Thereby maximizing public benefit of hatchery production and relieving fishing pressure on natural stocks.

CHAPTER 5

OBJECTIVE V:

Power Planning and Management

CHAPTER 5

OBJECTIVE V - POWER PLANNING AND MANAGEMENT

Introduction: As discussed previously, much of the decline of anadromous fish runs can be attributed to the failure of institutions responsible for power and river management and operation to adequately address fishery needs. Unless these institutions re-orient their decisionmaking and accept fisheries as a legitimate purpose in the management and operation of the power system, all of the substantive recommendations made in this report will meet the same fate as previous efforts. The Power Act provides for a new mechanism for improvement, but improvement will only occur with the cooperation of responsible utilities, power managers, and river management coordinators.

Traditionally, fishery needs have been treated as a secondary or "soft"constraint in the operation of the river, while power production has been considered as a primary or dominant constraint. In consequence, fishery needs are only taken into account after all major power system decisions have been made, if they are taken into account at all. This approach is both disruptive and conflict-ridden. Instead of attempting to accommodate disparities between fish and power production through advanced planning and early coordinated decisionmaking, fishery needs are treated as a last minute burden on power operations--if meeting fish needs looks difficult, the fish end up with little or nothing. In dry years, major political confrontations between fishery and power interests have become the norm.

The current situation cannot continue. Either the institutions responsible for power planning, management, and operation of the river must must modify their treatment of fisheries and incorporate fisheries into their basic assumptions for operation of the river, or the ultimate extinction of upriver runs must be accepted. Realistically, there is no middle ground.

The Power Act is an ambitious attempt to transcend the traditional treatment of fishery needs through new legislative requirements. Instead of

viewing fishery needs as external factors secondary to power generation, the Power Act requires the incorporation of fishery needs in power system decisionmaking. With respect to fisheries, this approach is the only way to preserve upriver salmon and steelhead. With respect to power production, this approach is the only way to use the flexibility of the power system to meet fishery needs efficiently and at minimum economic cost.

On repeated occasions, staff of the various utility, power management, and power coordinating groups have told fish and wildlife agencies and Indian tribes that they could certainly improve the treatment of fisheries in the power system if allowed or directed to do so. Because authority or directives of this sort have not been provided, the staff who actually run the power system and the river are hobbled in efforts to accommodate fishery needs. Simply stated, fisheries considerations have not been included as an integral component of job descriptions, performance guidelines, and organizational missions. If institutional change is actually to occur, it is the leadership of the utilities, power managers, and power coordinating groups who must actively re-orient and re-direct staff and organizational efforts, in a "top-down" approach.

Institutional change must be expected to encounter significant resistance from within the power system. As the agencies have seen from their experience with Bonneville Power Administration power sales contracts and similar issues, even minimal attempts to reflect or incorporate fisheries constraints provoke emotional objection from certain sectors. If incorporation of fisheries into the power system was going to be an easy task, it would have been done long ago using the authorities provided by the Fish and Wildlife Coordination Act. In essence, the Power Act directs that institutional resistance can no longer continue. Substantial effort, full cooperation from the power system, and patience is required.

Current Conditions: Before describing specific recommendations for improved power planning and management and fisheries representation, it is useful to first examine current conditions, i.e., how and to what extent fisheries are now being included in power system decisionmaking.

The Hydro-Thermal System

The current plans for the Northwest power system contemplate a transition from using hydroelectric power for baseload energy to the new "hydro-thermal" system, where hydroelectric power would be used for peaking and thermal power would be used for baseload energy. The transition to the hydro-thermal system is expected to occur during the current decade, the 1980's. Projected increases in hydroelectric peaking would result in increased intensity and duration of river fluctuations, an operation that would dramatically increase already severe impacts on anadromous fisheries. Nevertheless, fishery constraints on the hydro-thermal system have received no meaningful consideration; they are simply not assumed as basic limitations on system development and operations, unlike flood control, irrigation, and power generation.

In the late 1970's, in response to a legal challenge by the Natural Resource Defense Council under the National Environmental Policy Act, the Bonneville Power Administration prepared a draft environmental impact statement on the hydro-thermal system and the "one utility concept." In 1980, the draft statement was revised, followed by a final environmental impact statement entitled, "The Role of the Bonneville Power Administration in the Pacific Northwest Power Supply System" (January 21, 1981). In order to encourage incorporation of fishery constraints on hydro-thermal operations, particularly peaking operations, National Marine Fisheries Service and others submitted detailed comments on the draft statement. For the most part, comments of National Marine Fisheries Service went unaddressed in the final statement, as discussed previously.

Optimal use of the Columbia River system for the hydro-thermal concept has been assumed among utilities and power managers as the future framework of the Northwest power system. Clearly, this assumption must be modified in view of Power Act requirements for protection, mitigation, and enhancement of anadromous fisheries, including related spawning grounds and habitat. However, to date, the concept of the hydro-thermal system remains a tenet of the power system.

Power Planning and Management

Power planning and management throughout the Northwest is constrained and guided by several agreements and by well-established utility practice. For outside observers, it is sometimes difficult to distinguish between the two, and they are frequently equated by Northwest utility representatives.

The applicable documents for power planning and management include the U.S.-Canada Columbia River Treaty; the Pacific Northwest Coordination Agreement; the Mid-Columbia Hourly Coordination Agreement; Memoranda of Understanding between Bonneville Power Administration and the Corps of Engineers and the Bureau of Reclamation, respectively; the Intertie Agreement; and various contractual agreements for transmission and scheduling of power. Related practices include the operation of the Columbia River Water Management Group, preparation of the assured and detailed operation plans, the preparation of annual and weekly operating plans, the development of the Pacific Northwest Utilities Conference Committee Westgroup Forecast, and Bonneville Power Administration power scheduling arrangements with federal water management agencies. In virtually all of these agreements and activities, fisheries receive minimal, if any consideration, and fish and wildlife agencies and Indian tribes are unrepresented. Without full representation and consideration at this level of power system decisionmaking, fishery interests are beggars rather than full participants in the determinations of river management flexibility for multiple uses.

The Committee on Fishery Operations

Within the full range of power planning and management decisions, fisheries representation is limited to participation in the Committee on Fishery Operations (COFO), which was established in 1976 under the

auspices of the Columbia River Water Management Group.*

Current membership on COFO consists of the National Marine Fisheries Service, Fish and Wildlife Service, Oregon Department of Fish and Wildlife, Washington Departments of Fisheries and Game, Idaho Department of Fish and Game, Columbia River Inter-tribal Fish Commission, Corps of Engineers, Bonneville Power Administration, Bureau of Reclamation, the mid-Columbia public utility districts, and the Idaho Power Company. COFO is an ad-hoc group, with no formal membership, no written charter, and no clearly defined status. As a consequence, the role of COFO has emerged over time, and it currently acts as a more effective vehicle for expression of fishery interests than it has in the past.

Generally, COFO performs in the following manner. In November, the Committee meets to prepare a report on the previous year's operations concerning juvenile migration. Early in the year, COFO meets to prepare an Implementation Plan for the juvenile migration period, which generally includes a fishery operating plan and specific implementation responsibilities, with primary emphasis on flows, spill, and research. The Implementation Plan is then used by the water management agencies in establishing their spring operations.

COFO as it presently functions has not provided fisheries agencies with full partnership and equality in management of the river. The Committee, lacking authority, operates using the lowest common denominator, doing

*The Columbia River Water Management Group was established in 1967. The purpose of the Group is "to consider problems relating to operation and management of water control facilities," including compilation of project operation data and water-use requirements and seasonal runoff forecasting. Membership is drawn from agencies "involved in the operation and management of water control facilities or forecasting of streamflows," and currently includes Bonneville Power Administration, Bureau of Reclamation, Corps of Engineers, and others.

the best job possible given the constraints imposed on implementation of fishery needs. The COFO Implementation Plan contains little directive of a binding nature, relying on wording such as "every effort," "will attempt to," "may allow," "insofar as possible" to condition the commitment of the federal water managers and non-federal project operators. Nevertheless, COFO has heralded the start of a new cooperative effort, and COFO activities on behalf of fish have clearly improved over the years.

In the past two years, the COFO Implementation Plan has lead to the establishment of the position of Smolt Coordinator, a full-time position funded by Bonneville Power Administration. During the juvenile migration period the Smolt Coordinator coordinates flow and spill from April to June, as well as hatchery releases related to flow operations. The Coordinator also monitors the progress and success of juvenile outmigration. This development of a Coordinator position has been a promising new outgrowth of COFO for power and fishery operations. The funding of such a position by Bonneville Power Administration is recognition of the budgetary limitations which constrain involvement of the fishery agencies in power planning, management, and operation decisions.

Other Areas

The fishery agencies and Indian tribes are active in many proceedings and review processes which concern the relationship between power production and anadromous fish, with the goal of preserving the resource and restoring productive sport, commercial, and Indian fisheries. The fishery agencies generally participate in accordance with the Fish and Wildlife Coordination Act and related authorities, while the Indian tribes generally raise issues related to treaty obligations.

Comment and participation generally fall into three categories: comment on environmental review documents for federal projects, participation in proceedings for non-federal hydroelectric projects, and review and comment on new initiatives under the Power Act.

In the first category representative agencies and tribes generally submit detailed comments on proposed power-related developments at federal projects on the Columbia and Snake rivers. For example, authorization and construction of the Bonneville Second Powerhouse, authorization of the McNary Second Powerhouse, and modification of other existing projects received detailed review and comment. Fishery agency experts on fish passage design criteria worked closely with the project operators to minimize the impact of the developments and to seek improvements where possible.

In the second category, representative agencies and Indian tribes are frequent intervenors in proceedings before the Federal Energy Regulatory Commission. These include license decisions on projects operated by Idaho Power Company on the Snake River and by Grant, Chelan, and Douglas counties public utility districts on the Columbia River. In the past, agency representatives have also participated in Federal Energy Regulatory Commission proceedings concerning the proposed Asotin Project on the Snake River, a project which was not pursued based on adverse fishery and other environmental effects.

In the third category, representative agencies and tribes have submitted detailed comments, participated in hearings, and attended negotiations concerning several Bonneville Power Administration initiatives under the Power Act. To date, these include power sales contracts, billing credits, resource acquisition, and rates. In the future, other areas of involvement will include environmental cost-benefit evaluations and other aspects of power planning and management.

In all of these activities, the fishery agencies and Indian tribes are generally viewed as "outsiders" to the process, accorded a role which differs little from the role of an interested member of the public. Few concessions have been made to the agencies and tribes' responsibilities, substantial expertise, and legal rights in fishery matters. Their comments and advocacy have met with mixed response from utilities and others and have not generally resulted in significant improvements to anadromous fishery resources.

Subobjective 5.1: Ensure that formal agreements respecting planning and management of the power system, and utility practices in planning and management of the power system, fully internalize the fisheries program and provide for equitable treatment of fisheries.

Task 5.1.1: Within one month of program adoption, obtain a Bonneville Power Administration written report which analyzes power system decisionmaking to assess where and how the fisheries program (including amendments) can be fully accommodated.

Discussion: The Bonneville Power Administration analysis should be comprehensive, detailed, and written in lay terms; should highlight and explain decision points where fisheries input could be provided at the earliest possible opportunity; and should be designed to fully utilize the flexibility of the river and power system to meet fisheries objectives at minimum cost. Specific areas addressed in the report should include but not be limited to power planning meetings under the Pacific Northwest Coordination Agreement (including the annual 6(d) meeting), planning pursuant to the U.S.-Canada Columbia River Treaty, development of operating criteria, actions under the Northwest Power Pool Principles and Procedures, federal power scheduling decisions, intertie arrangements, and transmission agreements.

In view of Bonneville Power Administration's expertise in power system decisionmaking and the urgent need for an analysis of this sort, a one-month deadline is recommended.

As discussed previously, institutional changes are critical if the Fish and Wildlife Program is to have its intended remedial effect on the Region's anadromous fishery resources. The Bonneville Power Administration report will provide a blueprint of the necessary institutional change and assist the new partnership and equal status of fisheries in power system decisionmaking.

Additionally, the Bonneville Power report might well provide a basis for supplemental amendments to Objectives V and VI.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program direction to Bonneville Power Administration to prepare a written analysis of the power system decisionmaking and fisheries involvement within one month from program adoption.

Task 5.1.2: Prepare, as part of the fisheries program, a formal interpretation of the U.S.-Canada Columbia River Treaty, and develop a formal agreement with the designated U.S. entities that fish flows will be incorporated into short- and long-term planning under the Treaty.

Discussion: The United States-Canada Columbia River Treaty is frequently described as excluding, and in fact, prohibiting operations beneficial to fisheries. This interpretation of the Treaty is cited to buttress contentions that the extensive Canadian storage cannot be utilized to meet fish flow requirements. However, an examination of the Treaty does not dictate such a restrictive reading.

Although fisheries purposes are not specifically mentioned in the Treaty (as are hydroelectric power generation and flood control), "other benefits" associated with the expanded storage are recognized [(Preamble)]. These other benefits could certainly include fish flows. Additional sections of the Treaty also support this conclusion. For example, Article XI, entitled "Use of Improved Stream Flow," expressly provides for improved stream flows, even if not used for hydroelectric power generation. Moreover, Article VII(4) of the Treaty specifically states that water may be released from storage and actually bypass the U.S. dams without power generation under the terms of the Treaty.

In this connection, it is interesting to note that the Columbia River Treaty's Permanent Engineering Board, in its Annual Report to the Governments of the United States and Canada, September 30, 1979 states:

> "Streamflows have been manipulated for nonpower purposes such as accommodating construction in river channels and providing water to assist the downstream migration of juvenile fish in the United States. These arrangements will supplement Treaty operation plans and have not created conflicts with operations under those plans. The effects have

been beneficial in both countries in accordance with the intent of the Treaty."

Instead of a Treaty prohibition, there appears to be an economic prohibition against to use Canadian storage for fish flows. If water is released for fish and is also used for hydroelectric power generation, then Canada is entitled to one-half of the downstream power benefits. On the other hand, if water is released and bypasses the dams (which would occur in case of spill to aid fish migration), then the entitlement of Canada is satisfied. Of course, water released from storage for fish flows would most likely be used for hydroelectric generation, although the timing of generation may not assure a top price.

Furthermore, the Canadian entitlement to one-half of the power benefits is less of a complication than it might first appear. Canadian entitlements have actually been transferred to U.S. utilities, which in turn have transferred the entitlement power to the Bonneville Power Administration.

Implementation of the Treaty occurs within the framework of short and long-term hydroelectric operating plans. To utilize the full flexibility of the Northwest power system in furtherance of the fisheries program, the operating plans must be revised to include fish flow requirements as basic planning assumptions.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program a formal interpretation of the United States-Canada Columbia River Treaty and obtain a formal agreement which will provide that development of all hydroelectric operation plans incorporate and implement the Fish and Wildlife Program (including amendments).

Task 5.1.3: That the Power Planning Council as part of the fisheries program make a formal interpretation and if necessary, an amendment of the terms of the Pacific Northwest Coordination Agreement, which reflects the requirement that the fisheries program (as amended), including equitable treatment of fisheries, be incorporated into all aspects of power planning and decisionmaking under the agreement.

Discussion: Like the Columbia River Treaty, the Pacific Northwest Coordination Agreement is frequently cited as prohibiting fisheries-related project operations. In the case of the Coordination Agreement, this contention is contradicted by the actual terms of the Agreement. Section 15 provides:

> Nothing in this agreement shall require a party to operate a project in a manner inconsistent with its requirements for nonpower uses and functions, and no party shall be considered in violation of this agreement or suffer any penalty thereunder because of any project operations undertaken in good faith for the purpose of preserving priority to such nonpower uses or functions..."

Clearly, "requirements for nonpower uses and functions" must include operational constraints designed to protect, mitigate, and enhance fish and wildlife. In meetings and decisions made pursuant to the Coordination Agreement, including the annual planning meeting pursuant to Sec. 6(d), this means that fishery constraints must be brought to the table as basic planning assumptions.

Apparently, past disregard of fishery constraints have focused on the term "requirements." Some fishery constraints have been viewed by the parties to the Agreement as "hard" requirements, which must be assumed in power planning, while others have been viewed as "soft" requirements. Soft

requirements are accommodated only if they can be easily met within other "hard" constraints, such as power generation and other commitments.

Accordingly, the fishery agencies and Indian tribes recommend that a formal interpretation be obtained from the parties to the Coordination Agreement which clarifies that the fisheries program must be considered as a "requirement for nonpower uses and functions" within the meaning of the Agreement. This would mean that the fisheries program would be established as a basic assumption in planning and decisions conducted under the Agreement.

There is some precedent for this interpretative approach to the Coordination Agreement. An October 1, 1981 contractual letter prepared by Bonneville Power Administration concerning the recent long-term power sales contracts essentially provides a new interpretation of the Coordination Agreement. If an interpretation of the Agreement would not be possible, then modification must be considered.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program a formal interpretation, (and if necessary, require an amendment of the terms), of the Pacific Northwest Coordination Agreement which reflects the requirement that the fisheries program (as amended), and equitable treatment for fisheries, be incorporated as a "hard constraint" into all aspects of power planning and decisionmaking under the agreement.

Task 5.1.4: Require the use of fishery operating criteria in all power planning, management, and operations, to the same extent and on the same basis as power rule curves.

Discussion: Perhaps the most important aspect of power planning, management, and operations is the development and use of rule curves, or guidelines for reservoir operations. Various rule curves control the operation of the system as a whole and of each hydroelectric project.

Just as operation of the system below power rule curves may jeopardize power production, operation of the system below fishery flow requirements would jeoparidize fishery production. Fishery operating criteria would be developed from the flow requirements established in the Fish and Wildlife Program.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the development of fishery operating criteria as a practical method of implementing the fisheries program and reflecting the equitable treatment standard of Sec. 4(h)(10) of the Power Act.

Task 5.1.5: Require that all aspects of power planning and management reflect in an equal manner the probability of achieving fishery objectives with the probability of achieving power objectives.

Discussion: A double standard exists in the treatment of fisheries and power with respect to "safety factors" on reliability requirements built into decisionmaking. With regard to power, numerous safety factors have been institutionalized in power system decisionmaking, in an attempt to ensure the system against the risk of a power insufficiency under even the most severe of circumstances.

In contrast, fisheries are provided with no similar safety factor. Actually, fisheries needs are inadequately accommodated in the system even without the use of a safety factor. Because disregard of fish needs is frequently justified by the need to accommodate system "reliability" requirements, fisheries are essentially serving as the insurer for the power system. Fishery requirements are withheld in order to provide a cushion for power generation in the remote probability of worst-case conditions for power generation.

Recommendation: The fishery agencies and tribes recommend that the probability of achieving fishery objectives and the probability of achieving power objectives be comparable in all aspects of power planning and management.

Task 5.1.6: Obtain Memoranda of Agreement with Bonneville Power Administration, the Corps of Engineers, and the Bureau of Reclamation which explain how the agencies will utilize the Fish and Wildlife Program and provide equitable treatment for fisheries in carrying out their responsibilities for power operations, scheduling, and river management.

Discussion: Operation of federal water project reservoirs is controlled by the Corps of Engineers and the Bureau of Reclamation, in cooperation with the Bonneville Power Administration. Detailed operating arrangements are set out in Memoranda of Agreement between Bonneville Power Administration and the Corps of Engineers and between Bonneville Power Administration and the Bureau of Reclamation. Under the Memoranda of Agreement, arrangements are made for scheduling and availability of power, conditioned on compliance with other nonpower project purposes. For example, the agreement between Bonneville Power Administration and the Corps of Engineers limits power-related commitments if those commitments would:

-- conflict with statutory requirements for operation with regard to flood control, navigation, irrigation, recreation, or other such purposes projects are to serve;

-- impair effective operation of project fish passage facilities;

-- insofar as practicable, have harmful effects on the environment, including fish and wildlife resources.

These limitations do not clearly explain how Bonneville Power Administration, the Corps of Engineers, or the Bureau of Reclamation will implement their obligations under the Power Act, including obligations with respect to the fisheries program. Particular questions involve reservoir operations and releases, particularly in view of recent power contracts which authorize Provisional Energy and FELCC Shift, and recent Bonneville Power Administration contractual letters setting out a similar Economic Shift.

Provisional Energy, FELCC Shift, and Economic Shift all have potential to impair fishery flows.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program obtaining Memoranda of Agreement with the Bonneville Power Administration, the Corps of Engineers, and the Bureau of Reclamation which will provide binding and detailed recognition of fishery requirements and explain how these agencies will utilize the Fish and Wildlife Program and provide equitable treatment for fisheries in carrying out their responsibilities.

Task 5.1.7: Require that Bonneville Power Administration prepare a system-wide annual operating plan which incorporates the Fish and Wildlife Program and reflects equitable treatment of fisheries.

Discussion: Proper system management which strikes a balance between fisheries and power must begin with balanced planning, an exercise which has so far been lacking. In order to remedy this deficiency, assist in implementing the fisheries program, and satisfy the requirements of the Power Act and applicable environmental law, Bonneville Power Administration should prepare a system-wide operating plan which integrates fisheries in the management and operation of the power system.

An annual operating plan must be considered a cornerstone of efforts to improve institutional treatment of fisheries. The plan should be prepared in consultation with the fishery agencies and Indian tribes, and should fully reflect their comments and recommendations.

There is some precedent for a special purpose annual operating plan. For example, the recent Bonneville Power Administration power sales contracts with the direct service industries impose just such a requirement.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program direction for an annual system-wide operation plan to be prepared by Bonneville Power Administration, incorporating the fisheries program and providing equitable treatment of fisheries.

Subobjective 5.2: Assure that all Bonneville Power Administration and Federal Energy Regulatory Commission decisions (particularly regarding new hydroelectric development) reflect and include protection, mitigation, and enhancement of fisheries and equitable treatment of fisheries.

Task 5.2.1: Assure that all Bonneville Power Administration decisions (including decisions concerning contracts, billing credits, resource acquisition, environmental cost-benefit methodology, forecasting, and rates) incorporate requirements to protect, mitigate, and enhance fisheries and provide equitable treatment for fisheries.

Discussion: Many actions being undertaken by the Bonneville Power Administration under the Power Act have the potential to affect anadromous fishery resources, particularly in their institutional and financial support for hydroelectric projects.

Bonneville Power Administration decisions concerning billing credits and resource acquisition for hydroelectric facilities must include development of substantive criteria design to protect, mitigate, and enhance fisheries. (see Criteria for New Hydroelectric Projects set out in Task 5.2.2.) Based on these criteria, Bonneville Power Administration must approve, condition, or deny billing credits or resource acquisition for such facilities.

Bonneville Power Administration decisions concerning environmental cost-benefit methodology must be based on innovative and improved economic techniques which include all aspects of quantifiable fisheries economic values, as well as other non-quantifiable values.

Bonneville Power Administration decisions on forecasting must include full recognition of the fishery constraints established in the fisheries and other provisions of the Power Act. Similarly, Bonneville Power Administration

decisions on rates must incorporate costs related to fish flows, mitigation, and compensation in keeping with funding mandates and authorities under the Act.

Bonneville Power Administration contractual arrangements to meet load, transmission, and other obligations must be interpreted consistent with Bonneville Power Administration obligations to protect, mitigate, and enhance fisheries and provide equitable treatment for fisheries. As noted above, this includes contractual arrangements related to provisional and shifted energy.

Finally, other aspects of Bonneville Power Administration decisions must reflect fishery considerations. For example, conservation and load management should be viewed as power resources complementary to fishery needs. Load management can help to reduce long-term peaking demand, minimizing flow fluctuations destructive to anadromous fisheries. In the short-term, conservation upon request in dry years can help to assure water for fish flows. The complementary relationship between fisheries and conservation/load management resources should be fully recognized in all aspects of power planning and management.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program direction to require that all Bonneville Power Administration decisions (including decisions concerning contracts, billing credits, resource acquisition, environmental cost-benefit methodology, forecasting, and rates), incorporate requirements to protect, mitigate, and enhance fisheries and provide equitable treatment for fisheries.

Task 5.2.2: Assure that all Federal Energy Regulatory Commission, Corps of Engineers, and Bureau of Reclamation decisions concerning hydroelectric development provide for protection, mitigation, and enhancement of fisheries and equitable treatment of fisheries and are consistent with the legal rights of Indian tribes.

Discussion: Hundreds of new hydroelectric projects have recently been proposed for the Columbia River Basin and the Northwest. These include new "small" hydroelectric developments and projects at existing diversion dams, as well as numerous large or major projects. The majority of new hydroelectric developments raise questions concerning anadromous fishery protection. Cumulative adverse impacts to commercial, recreational, and tribal fisheries could be staggering.

Virtually all proposals for new hydroelectric development are now at the feasibility and evaluation stage. Project developers, including many investment groups from outside the Northwest lured by the prospects of high financial returns, have submitted record numbers of applications for preliminary permits to the Federal Energy Regulatory Commission (Preliminary permits reserve a dam site for an applicant pending feasibility studies and evaluations). Many of these are standard form applications, most devote little attention to fishery resources, and some fail to mention fishery resources at all.

For the most part, the FERC has issued standard form preliminary permits, and has not attempted to cull out projects which may not be feasible at the preliminary permit stage. Instead, FERC takes the position that questionable projects will fall out or be rejected at the license application stage.

The fishery agencies and tribes have intervened in many preliminary permit proceedings in an effort to ensure that critical fishery-related evaluations are conducted at the earliest possible opportunity. From past experience, the agencies and tribes have seen that routinely, only token

consideration is given to measures for the protection, mitigation, and enhancement of fisheries at the preliminary permit stage. When the time comes for submission of a license application, the project developer frequently will observe that specific fisheries measures require further "study" but will assert that issuance of the license should not be delayed pending such study.

From past experience, arguments for severance and postponement of fishery issues have been persuasive with FERC, which has issued long-term licenses with open-ended conditions for fishery studies in lieu of specific fishery measures. Open ended conditions for fishery studies effectively shift the burden of advocating and developing fishery measures from the licensee to the fishery agencies and tribes and, more often than not, have lead to significant delays and serious conflict over fishery mitigation and compensation. Open ended conditions for future fishery studies certainly do not represent equitable treatment of fisheries, unless FERC plans to also require fishery measures prior to power operations.

In this document, the fishery agencies and tribes have not found it possible or practicable to develop specific recommendations for each of the new hydroelectrtic projects proposed for the Columbia River Basin. However, the agencies and tribes have developed general criteria which should ensure that all new projects will include measures for the protection, mitigation and enhancement of fisheries, and that projects with severe and uncontrollable fishery impacts will not be approved.

These general criteria cover each of the major areas of fishery impact and fishery protection, as follows:

Fisheries Criteria for New Hydroelectric Projects

A. Fish Passage: Upstream and downstream fish passage must be provided to avoid delay, injury, excessive stress, and mortality to anadromous fish.

Fish passage for both upstream and downstream migrating salmon, steelhead and other anadromous fish must be provided to avoid delay, injury

and excessive stress. Required passage facilities must be installed during project construction and must be operated at all times that fish are present at the project. Initial project plans must include design of fish facilities. This should include and define type, location, size, method of operation and other pertinent characteristics. State and Federal fishery agencies input should be reflected in planning and design.

Upstream passage facilities are generally required at any project feature which impairs natural passage conditions. At some projects this may require a fish attraction system with fishway entrances correctly located and adequate attraction flows, a fish ladder, and an exit structure to return adults to the stream at an appropriate location upstream from the project. At other projects less extensive facilities may be required depending upon the degree of passage obstruction and other site specific characteristics.

For downstream migrating juveniles, the basic need is to screen turbine intakes to prevent the fish mortalities associated with passage through the turbines by excluding fish from the intake flow. Requirements concerning screen areas and mesh sizes must be satisfied to assure acceptable operation. A bypass flow to safely carry fish from in front of the screens to an appropriate location below the project is a fundamental need. Frequently a system of ports and bypass pipes is required.

All passage facilities must be designed and maintained to function properly through the full range of flows normally occurring during fish migration periods. The facility design should reflect the results of site specific studies and consultation with fisheries agencies.

B. Flows and Water Quality: Adequate flow regimes and water quality must be provided for successful spawning, incubation, rearing, and migration.

Adequate flow regimes and water quality are critical for anadromous fish. Consequently, flow regimes and water quality sufficient for successful spawning, rearing and migration must be established and maintained through and downstream of the project area where needed. If flow reduction, diversion or modification of flow regimes are anticipated in the operation

scenario for the project, anadromous fisheries could be adversely affected not only in the immediate project area but in the entire system downstream of the facility.

Adequate water quality is essential to the production of salmon and steelhead. Possible impacts to water quality could include all or several of the following.

1) Construction impacts such as siltation of spawning gravels or disruption of migratory behavior. Construction should proceed at times of least potential impact.

2) Temperature elevation or reduction.

3) Gas supersaturation which may occur due to plunging water and result in fish gas-bubble disease.

4) Reservoirs which tend to be nutrient traps may cause decreased fish production downstream by reducing available food supplies.

5) Silt laden reservoir releases which decrease invertebrate production and salmonid egg survival. This is a function of reservoir location and soils and should be identified during the planning process.

6) Disruption of flow patterns necessary for adult and juvenile fish migration and survival including rapid or large flow fluctuations resulting from power peaking operations.

7) Lack of gravel accretion downstream of reservoirs due to blockage of gravel movement which results in reduced spawning habitat.

C. Compensation for Unavoidable Losses: Compensation in the form of habitat improvements, artificial production, or similar methods must be provided to fully replace unavoidable losses.

Effective fish passage, flow regimes and water quality conditions are intended to avoid losses to existing and potential anadromous fish resources. Despite maximum use of these mitigation methods, losses to fish resources may occur either during or after construction.

An initial plan which recognizes contingencies such as unanticipated construction impacts must be developed as part of the license application. Subsequent refinements or modification of the plan may be necessary once the project begins operation and success of mitigation measures is evaluated.

D. Treaty Obligations:

1) No hydroelectric project shall degrade fishery habitat and reduce available harvestable fish in such a way that the moderate living needs of an Indian tribe can not be met.

2) No hydroelectric project shall result in the inundation of any usual and accustomed fishing place of an Indian tribe holding treaty fishing rights.

As noted in Chapter D, treaty fishing tribes are entitled as a matter of right to protection of fishery habitat from environmental degradation and protection of access to all usual and accustomed fishing sites. The construction of hydroelectric projects in the region and particularly on reservations and ceded lands may conflict with these rights.

E. Consultation: Project proponents must consult with fishery agencies and Indian tribes at all stages of project development, construction, and operation.

To ensure that proposals for new hydroelectric projects are consistent with the criteria described above, full consultation must take place between the project proponent (the Applicant, Federal Energy Regulatory Commission, Corps of Engineers, Bureau of Reclamation) and the fishery agencies and Indian tribes. This consultation should begin at the earliest stages of project

planning, and should continue throughout project construction and operation. The project proponent should provide the agencies and tribes with full access to all data and information related to the project.

F. Written Findings: All decisions to proceed with or license new hydroelectric projects must include written findings on all of the above criteria.

These criteria are intended as general interim requirements. Specific recommendations for fishery measures at new hydroelectric projects will be established in subsequent updates of this document.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the requirement that the Federal Energy Regulatory Commission, the Corps of Engineers, and the Bureau of Reclamation apply the Fisheries Criteria for New Hydroelectric Projects set out above, which provide for (1) fish passage; (2) flow regimes and water quality; (3) compensation; (4) Indian treaty obligations; (5) consultation; and (6) written findings. Specific measures for the protection, mitigation and enhancement of fisheries should be included in all license applications or federal project development documents. No license or license amendment should be issued without specific fishery measures. Severance and postponement of fishery issues should not be considered an acceptable alternative.

APPENDIX

APPLICATION OF THE NATIONAL ENVIRONMENTAL POLICY AND THE FISH AND WILDLIFE COORDINATION ACT TO HYDROPOWER MANAGEMENT AND PLANNING

The decisionmaking process of Northwest hydroelectric power system managers and operators encompasses planning decisions made 20 years in advance to computer decisions made very four seconds, 24 hours a day. While this process is complex, several points are identifiable where key decisions substantially shape the operation of the hydroelectric system of the Columbia River and its tributaries. Unfortunately, little consideration is given to the anadromous fishery at these determinative steps. See Blumm, Hydropower vs. Salmon: The Struggle of the Pacific Northwests' Anadromous Fish Resources for a Peaceful Coexistance with the Federal Columbia River Power System, 11 Envt'l 211, 249-256 (1981) (hereinafter cited as Hydropower vs. Salmon).

Both the National Environmental Policy Act (NEPA) 42 U.S.C. §§ 4331-44 (1976) and the Fish and Wildlife Coordination Act (Coordination Act) 16 U.S.C § 661-666c (1976) mandate that anadromous fishery considerations enter into the decisions of the hydropower managers. See Hydropower vs. Salmon at 262-276.

Regardless of how one dissects this management system, the result is the same. Collectively, the management and operation of hydroelectric facilities on the Columbia River and its tributaries have enormous adverse impacts on the annual migration of anadromous fish. The drafters of the Pacific Northwest Electric Power Planning and Conservation Act (Regional Power Act) 16 U.S.C. § 839 were well aware of this. The principal drafter of the fish and wildlife provisions in the Regional Power Act - the House Committee on Interstate and Foreign Commerce - included the following statement in its report:

> The existing practice of regulating flow of the Columbia River to maximize power revenues, including export of surplus power to the southwest, is the most critical factor causing a severe decline in upriver salmon and steelhead runs above Bonneville Dam.
>
> H.R. Rep. No. 96-976, 96th Cong. 2d Sess. 47 (1980), (Statement of John R. Donaldson).

Even when federal agencies reluctantly participated in operating dams to protect fish, their efforts were merely token - "[t]he net amount finally diverted from hydrogeneration was about 0.0016 of the annual unappropriated flows of the Columbia River at Bonneville Dam." Id. at 47 (statement of Ed Chaney).

I. National Environmental Policy Act

NEPA was designed to counter inevitable agency bias in favor of proposals that an agency has recommended. McDowell v. Schlessinger, 404 F. Supp. 221, 241 (W.D. Mo. 1975), citing Environmental Defense Fund v. Corps of Engineers, 470 F. 2d (8th Cir. 1972). Furthermore, NEPA requires federal agencies to internalize a procedure for assuring environmental protection. Rucker v. Willis, 358 F. Supp. 425, 428 (D.C.N.C. 1973) aff'd. 484 F. 2d 158. See also M.P.I.R.G. v. Butz, 498 F.2d 1314 98th Cir. en banc 1974).

To alter federal agency decisionmaking, NEPA mandates various procedures that obligate agencies to use "all practicable means" to improve and coordinate federal plans, functions, and programs to achieve the Act's goals. 42 U.S.C. § 4331 (b) (1976). Thus environmental protection has become an affirmative obligation of all federal agencies, giving them substantive authority base their decisions on environmental grounds. Gulf Oil vs. Morton, 493 F.2d 141, 145 (9th Cir. 1973) (quoting Calvert Cliffs' Coordinating Committee v. A.E.C., 449 F.2d 1109, 1112, (D.C. Cir 1971). This authority exists unless there is a clear statutory conflict that is both

fundamental and irreconcilable. Texas Committee on Natural Resources vs. Bergland, 573 F.2d 201, 206 (1978) cert. denied 439 U.S. 966 (1978).

While section 202(2)(c) of NEPA, requiring environmental impact statements, has been the focus of attention in the past decade, the following NEPA provisions mandate changes in an agency's decisionmaking structure even in the absence of environmental impact statement requirements. Hanley vs. Kleindienst, 471 F. 2d 823, 834-835 (2d Cir. 1972) cert. denied, 412 U.S. 908 (1973). See also, Commonwealth of Puerto Rico v. Muskie, 507 F. Supp. 1035, 1049-1056 (D.P.R. 1981).

NEPA directs that "to the fullest extent possible" all agencies of the federal government shall:

(A) utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decisionmaking which may have an impact on man's environment;

(B) identify and develop methods and procedures, in consultation with the Council on Environmental Quality established by subchapter II of this chapter, which will ensure that presently unqualified environmental amenities and values may be given appropriate consideration in decisionmaking along with economic and technical considerations;

(E) study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternatives uses of available resources;

(H) initiate and utilize ecological information in the planning and development of resource-oriented projects 42 U.S.C. 4332 (a)(b)(e) and (h) (1976).

There are obvious unresolved conflicts concerning alternative uses of the Columbia River and its tributaries. As mentioned, operation of the hydroelectric facilities on the Columbia and its tributaries to maximize power benefits conflicts with management of the Columbia River to provide flows for

anadromous fish. Where resource conflicts exist, federal agencies have a duty to study develop, and describe appropriate alternatives. NRDC vs. Callaway, 524 F.2d 79, 93 (CA 21975). This duty exists independent of the duty to prepare an environmental impact statement. Id. Furthermore, this duty is of wider scope than the type of consideration required by section 102 (2) (C); it demands the study, development, and description of alternatives, whereas section 102(2)(C) requires only a detailed statement. Id. 92-93.

Minimal consideration is given to fisheries' needs by the Bonneville Power Administration and the Corps of Engineers in the development of Assured and Annual Operating Plans. Because these plans delineate the parameters of drafting and refilling treaty storage projects, the absence of fishery consideration is manifested by the absence of fish-related flows from these projects. Similarly, the annual operating program by the Northwest Power Pool is notable for its lack of fishery considerations.

In short, the Bonneville Power Administration and the Corps of Engineers, as integral parties in the planning and management of the hydroelectric system of the Columbia River and its tributaries, have a legal duty to study, develop, 6and describe alternatives for managing conflicting hydropower and fishery uses; and this duty exists independent of the obligation to prepare an environmental impact statement. Additionally, NEPA requires that federal agencies use a systematic, inter-disciplinary approach to insure that intergrated use of natural sciences and environmental design arts is employed in all federal agency decisionmaking involving agency actions, again even where preparation of an environmental impact statement is not required. McDowell vs. Schlessinger, 404 F. Supp. 201 (D.C. MO. 1975).

While not a cure-all, compliance by appropriate federal agencies with their NEPA obligations will substantially improve the chances for improving the Columbia River anadromous fishery.

Finally, NEPA may require a programmatic environmental impact statement (EIS for the annual plans that govern the coordinated operation of the hydroelectric facilities on the Columbia River and its tributaries. See, Hydropower vs. Salmon, 265-268. An annual EIS would be a method to

assure systematic and interdisciplinary consideration of river flow manipulation to protect anadromous fish. At present, hydroelectric management and operational decisions are made with little disclosure to the public. Opening this decisionmaking process to public review could cause substantial changes in critical areas of the annual operating plans.

II. Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act1/ (FWCA or the Act) was enacted in 1934 to address the need for maintenance and restoration of productive habitats and environmental quality while allowing for economic development. To accomplish this, the Act provides a procedural framework for the consideration of fish and wildlife conservation measures in the planning and development of federal or federally licensed water projects.

The mandates of the Act essentially make consideration of costs and benefits of wildlife protection one of the integral purposes of water resource planning. To date the legal mandates of the Act have taken a back seat to the political and policy decisions made in implementing water development projects. The result has been obvious degradation of fish, wildlife, and habitat.

FWCA has four principal provisions that require federal and state agencies to coordinate their policies with regard to water development projects. These provisions amend, condition, or supplement other federal laws.2/

The first provision requires that wildlife conservation receive "equal consideration" and be coordinated with other features of water resource development programs.3/ The plain meaning of this language is that water development and operation plans may not proceed unless fish and wildlife are given equivalent value with the purposes of each individual project.

The second provision of the Act mandates consultation with the Fish and Wildlife Service, National Marine Fisheries Service, and appropriate state fish and wildlife agencies by water development agencies before a project is

authorized or undertaken.4/ Recommendations made by the fish and wildlife agencies in the consultation process must be specific enough to serve as functional means to protect fish and wildlife.5/

The third provision demands that water development agencies give "full consideration" to those recommendations.6/ Developers should integrate the recommendations into any project report and treat them with the objective of maximizing overall project benefits through justifiable means and measures.7/ Justifiability should not be viewed as an isolated cost/benefit analysis to determine whether protective measures for fish and wildlife can be adopted economically. Rather, the costs and benefits of fish and wildlife protection must be included in evaluating an overall project profile. If the economic and other costs of the project outweigh its benefits, the entire project should be abandoned, not just fish and wildlife protection.8/

The last principal FWCA provision gives federal agencies the power to implement the recommended measures through acquisition and use of lands and water for fish and wildlife purposes.9/ With powers of implementation explicitly provided, developers can legally comply with the the purpose of the procedural framework set forth in the Act.

It should also be noted that the Act provides for development and improvement of wildlife preservation measures 10/, along with the modification and/or supplementation of previously authorized projects.11/ Hence, mitigation of degradation already caused by existing projects must be considered in a continuing analysis of project impacts and available corrective measures. This should be specifically construed to include the protection of anadromous fish in the Columbia River system by maintaining adequate stream flows.

The foregoing description reveals a clear legal basis for protecting fish and wildlife resources affected by water projects. It is also clear, from the deteriorating condition of those resources, that federal water agencies have essentially ignored the legal mandate for fish and wildlife protection in favor of the other benefits derived from their projects. All involved agencies must

act immediately to maintain and improve the imperiled resources of the Columbia River.

FOOTNOTES

1. 16 U.S.C. §§ 661-666(c) (1976)

2. Regulations for implementing the Corps Rivers and Harbors Act of 1899 and the Clean Water Act obligate the Corps to consider the recommendations of the FWCA. Supplementary legislation is considered to include the federal reclamation laws and various flood control authorization. See Issues in Fish and Wildlife Planning. U.S. Fish and Wildlife Service, OBS-80/44. (August 1980).

3. 16 U.S.C. § 661 (1976).

4. Id. 662(a).

5. Id.

6. Id.

7. Id. 662(b).

8. See Blumm, Hydropower v. Salmon: The Struggle of the Pacific Northwest's Anadromous Fish Resource for a Peaceful Coexistence with the Federal Columbia River Power System, 11 Environmental Law 211, 271-72 (1981).

9. 16 U.S.dC. 663(a)(d) (1976).

10. Environmental Defense Fund, Inc. v. Andrus, 596 F.2d 848, 853 (9th Cir. 1979).

CHAPTER 6

OBJECTIVE VI:

Fisheries Representation

in River Management

CHAPTER 6

OBJECTIVE VI

References Regarding

River Management

CHAPTER 6
OBJECTIVE VI - FISHERIES REPRESENTATION

Subobjective 6.1: Establish a formal review process through which Bonneville Power Administration, the Corps of Engineers, and Bureau of Reclamation solicit recommendations from fishery agencies and Indian tribes in all significant power system decisions.

Discussion: Many aspects of power-related decisionmaking have implications for anadromous fishery resources. Under Section 4(h)(11)(B) of the Power Act, the Bonneville Power Administration, Corps of Engineers, Bureau of Reclamation, and the Federal Energy Regulatory Commission must consult with the fishery agencies and Indian tribes in their decisionmaking and must "to the greatest extent practicable" coordinate their actions. Once adopted, the Fish and Wildlife Program will provide the focus for that coordination.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program direction to effectuate the consultation and coordination requirements of the Act. The fishery agencies and tribes recommend that a formal process be developed by the federal power agencies to solicit fishery recommendations. This process could be established in a Memorandum of Agreement or in some other format.

Subobjective 6.2 Fund anadromous fishery coordinating personnel, initially comprised of the positions of Fishery/Energy Liaison Coordinator, Power Management Analyst, and Fishery Operations Manager.

Discussion: The recent experience with the use of a full-time "smolt coordinator" in connection with the annual Committee on Fishery Operations (COFO) Implementation Plan has revealed that the function is quite valuable. Funding for the position and required support staff has not been available through the existing budgets of the fishery agencies and Indian tribes and has been provided by Bonneville Power Administration. This recommendation is based on, but expands the "smolt coordinator" concept.

Of necessity, the fishery agencies and Indian tribes must become more knowledgeable and sophisticated in their dealings with river management and the power system. Yet the agencies and tribes generally lack staff and staff expertise on the complex planning, management, and operation of the projects or the system. Recognizing the importance of river management and power system management expertise in reconciling fisheries needs, representatives of the agencies and tribes have begun to educate themselves on the web of formal agreements, informal arrangements, and interrelationships that underlie the Northwest power system.

The fishery agencies and tribes can no longer rely on Bonneville Power Administration, the federal water managers, Federal Energy Regulatory Commission, or individual utilities for power system expertise. In fact, total reliance on these groups is what has triggered the piecemeal efforts to understand the power system to date. Because representatives from these groups have different missions and directives than the fishery agencies and tribes, their commentary on fishery-power operations understandably does not reflect a fishery-oriented perspective.

These piecemeal efforts have only underscored the inability of the agencies and tribes to fully monitor and participate in power system decisions. The agencies and tribes have concluded that they require full-time staff if

they are to perform these functions. At the same time, they have also concluded that these functions are critical for the protection, mitigation, and enhancement of fisheries.

To assist in anadromous fishery coordination, three positions will be funded. The first will be a Fishery/Energy Liaison Coordinator--someone with a biological background who would coordinate all operations and provide coordinated input to the energy management entities, particularly during the juvenile migration period. The second will be a Power Management Analyst--someone with an engineering or similar background who will monitor power planning and management decisions and provide technical advice to the Coordinator. The third will be a Fishery Operations Manager who will serve as the manager for all fisheries field operations and provide technical advice to the Coordinator.

The efforts of the this staff would be closely coordinated with the Northwest Power Planning Council, Bonneville Power Administration, and project operators, and the staff would provide a focal point for input of energy entities to fisheries operations.

The three staff positions will enable the fishery agencies and tribes to have major input to fishery-power decisions. The staff will be responsible for full coordination with the federal and state fishery agencies and Indian tribes. The precise manner of coordination will be agreed upon by the agencies and tribes at a later date.

With the assistance of the three staff members, the state and federal fishery agencies and Indian tribes will receive reports on fisheries improvements under the Power Act, evaluate the implementation of the fisheries program, coordinate fishery agency and Indian tribe input to Bonneville Power Administration, the Power Planning Council and others to the extent feasible, and monitor the annual system-wide operation plan.

More specifically, the Fishery/Energy Liaison Coordinator would expand on the current position of smolt coordinator, and would oversee fisheries input into power system planning, coordinate flows, monitor the juvenile and adult migration, oversee fish passage efforts, and perform other such tasks.

On the other hand, the Power Management Analyst would be a completely new position, directed toward changes in short-term and long-term power planning and management to improve the fishery operations monitored by the Fishery Operations Manager. The Power Management Analyst would review and participate in decisions by Bonneville Power Administration, the Corps of Engineers, the Bureau of Reclamation, and public and private utilities to ensure ongoing or improved management and operation for fisheries. Where appropriate, the Power Management Analyst through the Fishery/Energy Liaison Coordinator would also propose innovative power system initiatives to improve the ability of the system to accommodate fisheries at minimum cost, e.g., long-term power sales to exchange arrangements with California, increased reservoir storage, and possible purchase of water rights for fisheries.

Recommendation: That the Power Planning Council fund personnel to coordinate and to monitor progress in protecting, mitigating, and enhancing fisheries and providing equitable treatment for fisheries in river management and project operations, i.e. a Fishery/Energy Liaison Coordinator, a Power Management Analyst, and a Fishery Operations Manager. With the assistance provided by these three positions, the fishery agencies and tribes will provide coordinated interaction with power system decisionmaking.

Subobjective 6.3: Continue the Committee on Fishery Operations (COFO) as a fishery-power committee to monitor progress in protecting, mitigating, and enhancing fisheries and providing equitable treatment for fisheries in river management and project operations.

Discussion: The establishment of COFO in 1976 was a valuable step toward improved cooperation between fishery and power interests and has substantially improved the understanding of fishery and power problems. Nevertheless, COFO has operated within certain limitations, and many of these limitations are no longer valid with the passage of the Northwest Power Act.

The fishery agencies and tribes have proposed an improved system-wide procedure to carry forward the objectives of the Fish and Wildlife Program. Major fisheries input to the process would be provided by the the appropriate fishery agencies and Indian tribes with assistance from the three staff positions discussed in Subobjective 6.2. The agencies and tribes will assure that power system officials have definite contacts from among the fishery agencies and tribes and will provide unified responsibility, accountability, and input. Lack of specific contacts and clearly defined responsibilities for fishery-power deliberations has frequently impaired fishery agency and tribal efforts in the past.

Coordination among all of the fishery agencies and tribes in preparation for each year's operation will occur cooperatively with COFO. The fishery

agencies and tribes will prepare a general fisheries flow scenario for incorporation in the power management system. As runoff forecasts become available, the boundary conditions of the flow scenario will be refined and possible/probable events tested against the scenario. This will be done cooperatively by the agencies and tribes with COFO and will provide the basis for the guidance given the fisheries/power coordinating staff.

Implementation of the refined fishery flow scenario and associated activities on the part of the fishery agencies and tribes will be carried out by the Fishery River Management Coordinator, assisted by the Power Management Analyst, based on the guidance developed as described above. Current information on the progress of the smolt migration, etc., will be gathered according to a system to be developed by the fishery agencies and tribes.

Recommendation: That the Power Planning Council include in its Fish and Wildlife Program the need for a continuing coordination process such as COFO, that provides an interface between all energy management entities and fisheries management entities. However, specific recommendations of the fishery agencies will be provided directly to water management entities.

CHAPTER H

Conclusion

CHAPTER H
CONCLUSION: IMPLEMENTATION OF THE FISH AND WILDLIFE PROGRAM

After the Regional Power Council reviews these recommendations, solicits public input, and shapes the recommendations and input into a comprehensive fisheries program, the job has just begun. Recommendations and program measures are only so many words unless promptly and effectively acted upon by the Bonneville Power Administration, the Federal Energy Regulatory Commission, the Army Corps of Engineers, the Bureau of Reclamation, and public and private utilities. Fisheries must become a routine consideration in the power system. At the same time, innovative solutions--such as long-term power sales or exchange contracts with California, increased use of reservoir storage, and load management techniques--must be fully explored.

Because of its importance, the fishery agencies and tribes would like to conclude their submission to the Regional Power Council with some remarks on implementation of the fisheries program. Under the Power Act, the primary responsibility for implementation of the fisheries program will fall on the federal agencies. The federal agencies responsible for managing, operating, and regulating power projects must:

-- exercise their responsibilities consistent with the purposes of the Act to adequately protect, mitigate, and enhance fisheries, including related spawning grounds and habitat,

-- provide equitable treatment for fisheries with other project purposes,

-- exercise their responsibilities taking into account at each stage of decisionmaking to the fullest extent practicable, the fisheries program and,

-- consult with the fishery agencies and tribes in carrying out these obligations.

These express statutory directives impose a heavy burden on the Bonneville Power Administration, the Federal Energy Regulatory Commission, the Corps of Engineers, and the Bureau of Reclamation with respect to fisheries and the Fish and Wildlife Program. In fact, it appears that implementation of the Fish and Wildlife Program is the minimum level of compliance that can be expected of the agencies.

The application of the fisheries obligations to the Corps of Engineers and the Bureau of Reclamation should be relatively straightforward, since these agencies are directly responsible for the operation of federal hydroelectric projects. However, the application of fishery obligations to the Bonneville Power Administration as the power system manager and to the Federal Energy Regulatory Commission as the regulator of public and private utilities is more complex, and warrants some further discussion.

Under the Power Act, the Bonneville Power Administration has even more extensive fisheries obligations than those described above. In addition to the consistency with the purposes of the Act, the equitable treatment standard, responsibility to take into account the Fish and Wildlife Program, and consultation requirements, Bonneville Power Administration is directed to:

> "use the Bonneville Power Administration funds and the authorities available to the Administrator under this Act and other laws administered by the Administrator to protect; mitigate, and enhance fish and wildlife to the extent affected by the development and operation of any hydroelectric project of the Columbia River and its tributaries in a manner consistent with ... [the fisheries] program ... and the purposes of this Act." [Sec. 4(h)(10)(A), emphasis added.]

This is a strong, affirmative obligation. The Bonneville Power Administration must use all of its funding and authorities consistent with the fisheries program, and may not merely "take into account" the program. Bonneville Power Administration would appear to have even less discretion and more responsibility than other federal agencies in acting upon the Fish and

Wildlife Program and in developing innovative solutions for fishery program implementations.

To satisfy this responsibility, the Bonneville Power Administration Administrator and officials must scrutinize all aspects of their funding and power system activities, and must modify those activities as necessary to assist the Fish and Wildlife Program. Bonneville Power Administration system-wide activities must be used as a vehicle to assure implementation of the Fish and Wildlife Program by public and private utilities, with Bonneville Power Administration services conditioned on implementation as appropriate. There is no doubt that this will be a difficult effort, since it will essentially involve reordering of Bonneville Power Administration functions in the Northwest and may not be embraced by all Bonneville Power Administration customers. Yet the Power Act requires no less.

Similarly, the Federal Energy Regulatory Commission obligations under the Power Act will entail oversight of public and private utilities to ensure implementation of the Fish and Wildlife Program. And, as with the Bonneville Power Administration, this will require a certain reordering of Federal Energy Regulatory Commission functions and may meet utility resistance.

Although existing licenses and orders issued by Federal Energy Regulatory Commission for non-federal hydroelectric projects remain valid under the Power Act, existing licenses and orders may have to be modified to reflect the Fish and Wildlife Program in certain instances. House Commerce Committee Chairman Dingell described Federal Energy Regulatory Commission's new obligations and their relationship to existing licenses and orders in the following manner:

> Section 4(h)(11) of the bill supplements the Federal Power Act * * * I stress that the directive of section 4(h)(11) applies to FERC, not to a particular license, permit, or certificate, and to how FERC carries out its responsibilities under the law. The objective is that FERC use the authorities of the Federal Power Act to insure that the capabilities of each power project are

> fully utilized to provide operations that are compatible with the purposes of this legislation and will treat fish and wildlife as a coequal partner with other uses in the management and operation of the hydro projects of the region. The legal basis for initiating proceedings to make, and to make any changes or modifications in a license, permit, or certificate is the Federal Power Act and the conditions of the license or permit or certificate, as supplemented by this legislation, including this section. Where there is doubt about such legal basis in the case of any particular license and so forth, section 4(h)(11) is intended to resolve that doubt in favor of making those changes and initiating the proceedings to make such changes. [Cong. Rec. H-5104-05 (Dec. 1, 1980), emphasis added]

In the same remarks, Congressman Dingell also notes that "modification clauses" are contained in FERC licenses to trigger new proceedings and explains that "any Federal agency, including FERC, may cite this Act, particularly section 4(h)(11), as the legal basis for proposing, considering, or imposing such modifications in any pending proceeding or in future proceedings related to such validly existing licenses, permits or certificates." Thus, the Power Act, coupled with the Federal Energy Regulatory Commission authority to modify licenses and orders, should serve as a basis for imposing conditions designed to implement the Fish and Wildlife Program.

In closing, it is also important to stress the Power Planning Council's continuing obligations with respect to the Fish and Wildlife Program. Although the Power Act does not direct the Council in the same manner as the federal power agencies, the Council does retain an important oversight role for the Program. For example, in its annual report, the Council must include an assessment of the effectiveness of the Program along with potential revisions or modifications to the Program. The fishery agencies and tribes look forward to an active Council role in overseeing the implementation and effectiveness of the Fish and Wildlife Program, as well as program revisions which may develop through program implementation.

Of necessity, the Fish and Wildlife Program will be dynamic, at least during the period of its initial development and implementation. Through a dynamic program, including the continued involvement of the Council, fishery agencies and tribes have high expectations that the ultimate goal--improvement of anadromous fish runs--will be achieved for commercial, recreational, and tribal fisheries and the citizens of the Northwest.

APPENDIX

A–A

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NORTHWEST ELECTRIC LOAD SHAPING FOR FISH ENHANCEMENT

DRAFT REPORT

NOVEMBER 9, 1981

PREPARED FOR

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PORTLAND, OREGON

BY

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OLYMPIA, WASHINGTON

SUMMARY

The use of the hydroelectric system to provide Winter peaking energy in the Pacific Northwest has increasingly imposed hardships on Spring fish migration. Reduced flows during the Spring make migration difficult, exposing juvenile salmon to predators, disorientation, and other challenges to survival. As baseload thermal plants are intorduced into the system, the hydroelectric system is being relied upon to a greater and greater extent for seasonal supplies. The future, therefore, holds even more serious potential problems for salmon migration.

Numerous alternatives are available to assist migration. Reregulation of river operation, to provide adequate flows, is an essential element. The cost of doing so, under "worst case" conditions, are relatively minimal, about $18 million on an annual basis. Numerous other mitigation measures are available. Conservation programs which target Winter consumption can reduce the need to store water for seasonal generation. As total energy loads come down, thermal plant needs are reduced, and river flows are flattened out, compared with predicted operation under current demand forecasts.

The use of fuels which do not impose adverse environmental impacts can assist in moving electrical loads out of Winter, thereby reducing seasonal operation of the hydroelectric system.. A relatively simple program of "buying back" existing electric furnaces in residences which are adjacent to natural gas mains could reduce Winter loads by abo-t 2000 MW-months, more than twice the impact of the minimum requirements to assist fish migration. The electrical savings which would accrue to the region, after compensating heating customers for any additional cost of gas heat, would cost the region

1 to 20 mills per kilowatt-hour, much less than the cost of alternative additional energy resources. Such a program is obviously attractive, regardless of whether or not it is needed to enhance fish migration, but the reduction in Winter loads, and thus hydro storage requirements, would be beneficial to fisheries.

It may be possible to obtain access to about 679,000 acre-ft of water, now stored in Idaho reservoirs, which is presently dedicated to irrigation purposes, but has never actually been withdrawn for irrigation use. If obtained, this water could be used to provide the bulk of the incremental flows required in dry years to aid migration on the Snake River. If the water were desired for irrigation purposes, a 50¢/acre-ft charge would be imposed. So far, this has proven to be above the market value of the water for irrigation purposes. If released for power purposes, each acre-ft would produce approximately $200 worth of electricity, as it passed through existing dams. Idaho legislative approval would be required to change the status of this storage water, but offers promise to the region, both for power supply and for fish migration purposes. Financial compensation to the State of Idaho for release of the water would benefit both the state treasury, and regional ratepayers, while providing needed aid to migrating salmon.

In the event that additional generation is found to be necessary to meet future power loads, it is important that the region give consideration the development of generating resources which produce energy at times when regional loads require additional resources. Two sources in particular meet this test. Wind energy potential in the coastal areas of the Northwest peaks during the Winter months, in tandem with electrical loads. Certain Western Washington hydroelectric sites also would provide peak output in Winter.

In acquiring additional resources for the future, the region should give consideration to the seasonal nature of the output of specific resources. Assuming a marginal cost on an annual basis of 65 mills per kilowatt-hour for new generation, it is reasonable to allocate that on a seasonal basis. If secondary energy is available, on average, during the Spring for 30 mills, Winter energy would have to be valued at approximately 83 mills, in order to recover the average annual costs. It is against the higher seasonal cost that any new resources which have seasonal generating characteristics must be judged. For resources which produce energy on a baseload basis, the average value should apply. For those which produce energy primarily during the shoulder season, a lower value is appropriate. Conservation resources, of course, are primarily Winter resources, and should be valued accordingly.

Under some water conditions, it appears that operation of the hydro system to provide minimum streamflows to aid fish migration will result in generation in excess of that which can be used in the Northwest, unless existing load patterns are changed, or maintenance schedules for existing and planned thermal plants are revised. Revision of thermal maintenance schedules into April and May would allow the hydro system to be used to meet load, and thus by definition move additional water downstream. Predicted loads are all in excess of the expected generation from the hydro system, even during April and May, under revisions to river regulation needed to provide adequate fish migration in dry years. Thus, thermal maintenance schedule revisions alone may prove to be all that is necessary to provide adequate migration.

In the event that conservation and thermal plant rescheduling are insufficient to achieve the streamflow requirements imposed by consideration of fish migration requirements, the region will experience excess generation during the Spring months. In wet years, this will have the effect of moving secondary power sales forward in time, from June and July into April and May. The difference, in wet years, is insignificant. In dry years, however, the excess generation would otherwise have been stored until Winter, when a local market would be available. It is possible to store excess generation with California utilities under certain circumstances. The existing tieline capability of 4400 MW greatly exceeds the excess generation in dry years, so moving the energy South is not a problem. So long as contracts are offered to Southwest utilities which insure that they will not be forced to return energy which otherwise would have been unstorable, and they are not required to return energy during times when they are operating their highest-cost resources, an opportunity for a "fish water" power exchange agreement is clearly present. Our discussions with Los Angeles Department of Water and Power and California Energy Commission officials confirms that an exchange market is available to the Northwest for these purposes. The costs of such an exchange are minimal, and the benefits to fisheries are significant.

THE PROBLEM

Low cost electricity has made electric heat the most prevalent choice for residential and commercial heating needs. Extended hours of darkness in Winter months create an increased need for electricity in Winter. Moderate Summer weather in most of the population centers of the Northwest means that we have little need for air conditioning. The result of these and other energy use patterns in the Northwest has created a Winter peaking pattern for the regional electrical demand.

Downstream migration of juvenile salmon requires high river flows during the months of April, May, and June, quite opposite to the peak in power demand in December, January, and February. Operation of the hydroelectric system to meet current seasonal variations in power demand adversely affects salmon migration. On the other hand, operation of the system to meet fish migration needs impairs the ability of the system to meet power requirements.

The confrontation between fish and power becomes critical in dry years. In average and wet years, sufficient water is available to meet the needs of both power and fish. This analysis focuses on strategies to provide adequate streamflows in the driest 25% of the 40 year hydroelectric system model employed by the Army Corps of Engineers.

The problem is predicted to get more serious in the future than at present. Table 1 shows the predicted growth in monthly loads in Winter to exceed that of Summer. In January of 1985, for example, loads are expected to be 5600 MW higher than actual January, 1981 loads, while May, 1985 loads are expected to increase by only 3000 MW over May, 1981 actual loads. The increased shift of peak load into Winter suggests that current problems

TABLE 1

ESTIMATED FUTURE SEASONAL ENERGY LOAD

	2/81 WGF (Average MW)	Increase Over Actual 80-81 (Average MW)	% Increase
July '84	16588	2828	20.6
Aug	16584	2575	18.4
Sept	16314	2405	17.3
Oct	17913	3198	21.7
Nov	20609	4338	26.7
Dec	22001	4749	27.5
January '85	23181	5619	32.0
Feb	21609	3843	21.6
March	20418	4332	26.9
April	18951	3120	19.7
May	17841	2964	19.9
June	17553	2938	20.1
July '85	17071	3311	24.6
Aug	17061	3052	21.8
Sept	16801	2892	20.8
Oct	18420	3705	25.2
Nov	21215	4944	30.4
Dec	22677	5425	31.4
January '86	23884	6322	36.0
Feb	22248	4482	25.2
March	21010	4924	30.6
April	19502	3671	23.2
May	18363	3486	23.4
June	18083	3468	23.7
July '86	17563	3803	27.6
Aug	17545	3536	25.2
Sept	17249	3340	24.0
Oct	18905	4190	28.5
Nov	21786	5515	33.9
Dec	23314	6062	35.1

obtaining adequate flows for fish migration will be exacerbated in the future, unless other steps are taken to bring loads and resources into a better seasonal balance, without having to increase dependence on the hydroelectric system in the Columbia and Snake Rivers to meet seasonal load vatiations.

The vast majority of expected new energy capability in the region consists of baseload coal and nuclear plants. 6080 MW of nuclear generation, and about 2000 MW of coal-fired generation is now under construction. These units produce energy most economically when operated at as high a capacity factor as possible. Such operation is inconsistent with the need to increase Winter generating capability by nearly twice the level of Spring capability. Other new resources include such measures as generation from water running in irrigation canals; unfortunately, this energy is only likely to be available during Summer months.

The problem may not actually be as severe as the flow modeling being carried out by the Corps, in runs made for NMFS, suggests. Some mitigation of the problem has already occurred, and additional mitigation is both possible and likely. A review of actual changes in loads, compared with predicted changes indicates that Winter loads are growing much more slowly than estimated. Table 2 compares estimated and actual monthly loads for the West Group. In each case, the actual load has been compared with the load predicted for that period in the five-year earlier West Group Forecast.

While the consistent overprediction of the official utility forecasts has been documented in the past[1], this analysis shows that the overprediction has been much more significant in Winter months than in Summer months. For example, the average overprediction for December through February of 1977-81

TABLE 2

ESTIMATED VERSUS ACTUAL MONTHLY WEST GROUP LOADS*

	Actual Load (Average MW)	Estimate-Actual (From 5 Yr Earlier Forecast)	% Under (Over) Forecast
July '76	12416	1798	12.6
Aug	12536	1982	13.7
Sept	12518	2152	14.7
Oct	13550	1995	12.8
Nov	14801	2006	12.9
Dec	15862	2196	12.1
January '77	17013	1525	8.2
Feb	15042	2729	15.4
March	14861	2061	12.2
April	13230	2909	18.0
May	12771	2590	16.9
June	12285	2563	17.3
July '77	12047	2369	16.4
Aug	12295	2428	16.5
Sept	12093	2893	19.3
Oct	13181	2819	17.6
Nov	15370	1973	11.4
[illegible]	15991	2738	14.6
January '78	16294	2908	15.1
Feb	15816	2495	13.6
March	14772	2712	15.5
April	14754	1893	11.4
May	13984	1818	11.5
June	13705	1507	9.9
July '78	13122	1947	12.9
Aug	12895	2597	16.8
Sept	13301	2380	15.2
Oct	14197	2581	15.4
Nov	17389	842	4.6
Dec	18086	1624	8.2
January '79	20050	176	0.9
Feb	17836	1453	7.5
March	15585	2787	15.2
April	15239	2175	12.5
May	14286	2207	13.4
June	14311	1638	10.3
July '79	13970	2155	13.4
Aug	13828	2628	16.0
[illegible]ept	13557	3124	18.7
[illegible]	14564	3313	18.5
[illegible]v	17093	2406	12.3
Dec	17115	4103	19.3

TABLE 2 P.2

	Actual Load (Average MW)	Estimate-Actual (From 5 Yr Earlier Forecast)	% Under (Over) Forecast
January '80	19521	2194	10.1
Feb	17505	3105	15.1
March	16295	3279	16.8
April	14554	3996	21.5
May	14237	3344	19.0
June	14066	3004	17.6
July '80	13760	2790	16.9
Aug	14009	2907	17.2
Sept	13909	3058	18.0
Oct	14715	3377	18.7
Nov	16271	3445	17.5
Dec	17252	4728	19.9
January '81	17562	4509	20.4
Feb	17766	3098	14.8
March	16086	3692	18.7
April	15831	3065	16.2
May	14877	2966	16.6
June	14615	2800	16.1
July '81	14397	2729	15.9
Aug	14561	2925	16.7

*Total West Group Loads (Includes BPA Non-Firm)

was 2639 MW, while the average overprediction for April through June was slightly lower, 2565 MW. The roots of this overprediction include several problems; these problems will likely have an effect on future actual loads.

Continuing increases in power rates will most likely have the greatest influence on Winter loads. Research has indicated that large residential users (electric heat customers) are much more price-responsive than are small users.[2] New inverted rates, ordered by the regulatory commissions of Washington, Oregon, and Idaho, may make electric heat much more expensive than alternative measures, including conservation investments, wood heat, and gas heat. Low first block rates will have little effect on "basic appliance" usage, which is essentiall non-seasonal. Specific programs are underway to address electric heat conservation, while fewer specific programs are addressed at appliance and lighting usage, which are less seasonal. Programs are already underway to discourage electric heat. The Idaho PUC has imposed connection charges on new electric resistance heat customers of the Washington Water Power Company. The Oregon and Washington Commissions have also taken steps to curtail new electric heat connections. All of these changes, if effectively implemented on a regional scale, could alter growth patterns in electrical consumption, allowing Spring loads to grow more rapidly than Winter power use, thereby shifting streamflow from Winter to Spring.

REVIEW OF AVAILABLE MITIGATION MEASURES

We have reviewed a variety of mitigation measures which can assist in increasing Spring streamflows to assist migration of juvenile salmon. The alternatives are not mutually exclusive. Each of them has the potential to significantly improve migration. Together, the measures solve the problem several times over. Even partial implementation of each of the available measures could essentially meet the minimum flow requirements for fish migration.

OPPORTUNITY FOR RELEASE OF UNCONTRACTED IRRIGATION WATER

Research on this report has included an effort to determine if uncontracted irrigation water, now in "dead storage" could be made available for release in dry years to provide for enhanced fish flows. The total amount of water needed to meet the April-June incremental flows, above an beyond that expected to be used to meet predicted regional power needs, amounts to something less than 3 million acre-ft (40 kcfs in the second half of April, and 20 kcfs in May.)

Uncontracted irrigation storage exists on the Snake River in the amount of approximately 679,000 acre-ft. This water is held in four reservoirs, as shown below:

TABLE 3

RESERVOIR	ELEVATION	DRAINAGE	CAPACITY	UNALLOCATED STORAGE
Lucky Peak	3060'	Boise	306,000	116,000
Deadwood	5321'	Deadwood	164,000	105,000
Cascade	4835	Payette	704,100	378,000
Ririe	5119	Willow Ck.	100,000	80,000
			Total:	679,000

Reallocation of this water is attractive for a number of reasons. First, it would assit in meeting minimum fish flow requirements without diminishing hydrogeneration, but rather enhancing it. Given the high altitude of these reservoirs, significant power potential can be realized from release of this water, which has been stored through all recent droughts. Assuming an average working (generating) drop of 3000' on 679,000 acre-ft, a total of about two billion kilowatt-hours could be generated. Since this generation would allow other water to be stored for Winter use, the value of this generation is essentially the value of Winter energy. At 65 to 85 mills per kilowatt-hour, the value of the power which would be produced at existing Snake River dams is approximately $130 to $175 million, during the dry years in which this storage is released for power purposes.

Under present regulations, this water can be requested by irrigators for payment of a 50¢/acre-ft charge. This compares with a value of approximately $200 per acre-ft for power production purposes. One possible approach to obtaining releases of this water for power (and fish migration) purposes would be to offer the State of Idaho a financial incentive to reallocate the water. If BPA were to offer the Idaho state legislature an "avoided cost" settlement for the value of the power which would be generated at downstream federal dams, about $100 million could be made available to the state treasury in dry years. At the same time, this water would generate power at Idaho Power Company dams on the upper Snake, bringing additional low-cost power to the people of the state of Idaho and Oregon served by Idaho Power. Aggressive pursuit of this option could provide the region with an additional source of renewable energy in dry years, while at the same time enhancing fish migration.

A small amount of the water in Lucky Peak was withdrawn for irrigation purposes in the drought of 1977. Any negotiations with the state legislature in Idaho must recognize the potential for conflict with irrigators. The economic benefits of reallocation, however, are sufficiently great that it should be possible to compensate irrigators for lost value, and still provide an economical source of power and fish migration enhancement.

We have not aggressively pursued the availability of uncontracted irrigation water in Columbia River reservoirs. Grand Coulee, the largest irrigation project, is predicted to serve an additional half-million acres of land in the East Columbia basin. It has been argued that this use of water is uneconomical.[3] The political sensitivity of the potential East High development is of such a magnitude that negotiations for reallocation of this water would be very difficult. This does not imply that such a possibility should be disregarded.

RESCHEDULING OF THERMAL MAINTENANCE

Under present practices, thermal powerplant maintenance generally takes place in June-September. These are periods when runoff tends to be highest, and loads lowest. Such a practice has the effect of minimizing the Loss of Load Probability (LOLP), or the probability that instantaneous generating capacity will be insufficient to meet instantaneous loads.

As Table 4 shows, loads for 1985-86 are expected to exceed hydrogeneration under all circumstances, except for one month during the wettest of conditions, under the modified hydro regulation for fish migration. Basically, this tells us that rescheduling of thermal maintenance into

TABLE 4

ESTIMATED THERMAL LOADS UNDER "V" REGULATION

		Dry		Average		Wettest	
	1985-86 WGF Load	Hydro	Thermal + (-)	Hydro	Thermal + (-)	Hydro	Thermal
July	18,389	12,144	6,245	15,591	2,798	21,222	(2,833)
August	18,254	11,300	6,954	11,185	7,069	10,901	7,353
Sept.	17,745	9,121	8,624	9,533	8,212	13,398	4,347
Oct.	19,231	9,887	9,344	10,644	8,587	16,592	2,639
Nov.	22,183	11,935	10,248	13,143	9,040	16,447	5,736
Dec.	23,862	13,260	10,602	14,765	9,097	17,753	6,109
Jan.	25,114	14,503	10,611	17,776	7,338	19,248	5,886
Feb.	23,351	13,532	9,819	16,612	6,739	18,048	5,303
March	21,986	10,666	11,260	14,525	7,401	15,386	6,540
April	20,327	10,838	9,489	16,001	5,925	18,768	3,158
May	19,377	13,474	5,903	18,543	834	19,008	369
June	19,415	11,087	8,328	18,029	1,386	17,981	1,434

Thermal Loads Under "V" Regulation

JL:mj9/1

May could, in and of itself, completely eliminate the problems created by providing for adequate fish migration streamflows. In every month, including May, under dry or average conditions, loads would still be sufficient to use all available hydrogeneration, leaving a thermal decrement. It thus would not even be necessary to move all thermal maintenance into May. The thermal decrement will be lower under regulation for fish migration than under the base case scenario, but the residual decrement could be met either by providing additional flows for fish, further enhancing migration, or by operation of some thermal capacity.

The present practice of delaying thermal maintenance until Summer is a logical extension of the practice of seeking to maximize the probability of reservoir refill. Just as the mixiimization of reservoir refill probability results in spillage in years which do not turn out to be dry, late maintenance means that reservoirs are largely refilled by the time thermal plants come down, leaving less available storage for late runoff. An example of this is the situation of 1981, where Centralia was down for "economy" reasons in mid-Summer, while the intertie was underutilized in May. As a result, when high runoff occurred in July, it was necessary to spill 380,000 cfs at Grand Coulee for about a week. Had reservoirs been drafted lower, providing fish migration assistance (and returnable secondary to California) this additional runoff could have been stored, and subsequently used for generation. Return would have been unnecessary, as reservoirs filled with late runoff, and both NW and SW ratepayers would have benefitted financially.

Table 5 shows recent thermal downtime. While all causes, including economy and forced outage shutdowns are included, the preference for Summer thermal

maintenance is clear. This downtime occurs after the period when fishery migration would benefit greatly from additional hydrogeneration in April and May, which would result from earlier thermal plant maintenance.

TABLE 5

PLANT	PERIOD OF LOW GENERATION			
	1978	1979	1980	1981
Centralia	Mid-May-July	July-Aug	Mid-May-July	Mid-May-July
Hanford	June-July	May-July	June-Dec	June-July
Trojan	Apr-Dec	Mid-May-Ju	Mid-May-June	May-July

To provide for adequate fish migration, it is necessary that additional generation be achieved in April and May. Moving of thermal plant maintenance into these months will enhance the ability of the system to provide for fish migration, without significantly adversely affecting the overall output of the system on an annual basis.

In wet years, reservoirs are drafted early, to provide additional available storage for anticipated runoff. Such drafting also has the effect of providing for adequate fish flows. In such years, rescheduling of thermal maintenance may not be necessary as a fish migration tool.

CONSERVATION PROGRAMS

Under the terms of the Act, conservation is to receive top priority for future energy development. The majority of conservation programs now underway target residential consumption. This is beneficial for the purposes of fishery enhancement, since residential consumption is more seasonal than either

industrial or commercial power use. Residential conservation which addresses space heating needs, above all other programs, will help to flatten out regional loads over the year, and thus reduce the need for hydro storage.

The interaction between load reduction in Winter, and fishery enhancement is crucial to understand. Under the intent of the Hydro-Thermal Power Program, the intent of regional electric utilities was to build baseload generating plants, both coal and nuclear, and use the storage capability of the Columbia River increasingly for Winter peak operation. The problems which this approach caused for fisheries was the springboard for the inclusion of fishery protection, enhancement, and mitigation language in the Act.

If Winter loads are reduced by 2000 MW, while Summer loads are untouched, the need for approximately 1000 MW of baseload generation is eliminated. Since the baseload plant displaced would have met 1000 MW less than the Winter load, and 1000 MW more than the Summer load, the difference would be made up by storing water during the Summer, and releasing it in the Winter. The conservation of Winter loads, therefore, allows the Summer loads to be met by hydrogeneration. By meeting additional amounts of Spring load with hydro, fish migration is significantly enhanced. In a sense, then, the ideal resource is one which produces, or conserves, energy all Winter, but does little or nothing to reduce Spring loads or porduce Spring energy.

Table 6 lists numerous conservation and renewable resource measures, and an analysis of their seasonality. In concentration is placed on those measures which provide Winter savings, and baseload power demands are offset by a lesser amount than are Winter demands, the hydro system use

TABLE 6

APPROXIMATE SEASONAL SAVINGS AS A PERCENTAGE OF
TOTAL SAVINGS OF VARIOUS CONSERVATION AND RENEWABLE ENERGY SOURCES

	Winter	Spring	Summer	Fall
Insulation	50	25	5	20
Infiltration Reduction	50	25	5	20
Glazing	50	25	5	20
Heat Pump (Space Heat)	25	35	5	35
Passive Solar	25	40	10	25
Wood Heat	50	25	5	20
Solar Water Heat	15	30	30	25
Heat Pump Water Heat	20	25	30	25
Hot Water Efficiency Improvements	25	25	25	25
High Efficiency Appliances and Lighting	25	25	25	25
Wind* 1/				
Coast/Cascades	50	20	10	20
Coast Range/Rockies	40	25	10	25
Montana Plains	30	30	15	25
Small Hydro 2/				
North Puget Basin	25	35	15	25
South Puget/Olympics	35	25	10	30

*Locations with an average annual power density greater than
150 watts per square meter swept area (10 meter tower)
300 watts per square meter swept area (50 meter tower)

1/ Source: Wind Energy Resource Atlas: Volume I-The Northwest Region; PNL-3195 WERA-1 Battelle Northwest Labs.; April, 1980.

2/ Source: An Assessment of Potential Hydroelectric and Power Potential in Washington State; Washington Water Research; June, 1981.

will be flattened out, and fish migration enhanced. Given recent slippages in thermal plant schedules, it is imperative that the region reduce the growth rate of energy loads. A concentration of this effort on Winter loads will accomplish this purpose, while at the same time enhancing fish migration.

Table 7 provides one estimate of the magnitude of savings which are potentially available within the residential sector alone. The January estimate is derived from the seasonality factors in Table 6. The alternatives presented are not intended to be exhaustive or exclusive of other alternatives. The intent is to demonstrate the potential for reducing Winter loads, by promoting particular conservation strategies which target the loads which need to be reduced in order to both bring loads and resources into balance (both seasonally and in the aggregate) and to promote fish migration. The measures identified on table 7 provide savings which greatly exceed the load shift required to meet fish migration minimum flow requirements.

GENERATION ALTERNATIVES

Given the assumed loads in the most recent PNUCC forecast, the region will require generation above and beyond those projects now under construction (WPPSS 1-5, Colstrip 3/4, Valmy 1/2, Wyodak 2, and miscellaneous small projects.) If it is possible to develop resources which provide their peak output during Winter months, and relatively low output during the Spring migration season, the energy needs of the region can be met while simultaneously enhancing fisheries. As discussed earlier, the conservation alternatives detailed on Table 6 are such resources.

TABLE 7

RESIDENTIAL CONSERVATION POTENTIAL

	No. of Retrofits (In Thousands)	Total Kwh Savings/Year (In Millions)	Approximate January Million Kwh Savings
Insulation-Walls, Ceilings, Floors	1220	2877	468
Infiltration Reduction	875	1880	313
Glazing	360	1307	216
Space Heat Pump	484	1547	130
Heat Pump Water Heat	1946	2628	173
.ter Heater Insulation, Flow Restrictors	1946	2673	216
High Efficiency Appliances and Lighting	4765	1265	104
			Total = 1620
		Savings in Average MW:	2219

Source: Preliminary Comments of the Natural Resources Defense Council, Inc. on a Cost-Effective Regional Conservation Program for the Pacific Northwest; March, 1981.

Two particular generation alternatives meet this test as well. Several do not. In particular, wind generation and some small hydro installations West of the Cascade range are likely to provide Winter energy in excess of their output in other times of the year. Baseload plants, such as coal and nuclear units, by definition provide output on a more uniform basis. This dictates operation "out of sync" with the loads of the region, putting more pressure on the hydro system, and thus on fisheries.

Table 8 shows regions in the Northwest where wind energy tends to peak in Winter months. Table 9 shows those areas where wind levels tend to be high enough to support economical wind generation. The development of wind resources should obviously be concentrated in those areas where high winds, coupled with a Winter peaking pattern, can maximize energy production when needed.

Certain small hydro sites West of the Cascade range are well suited to the need to increase Winter energy production. Many of these sites are environmentally sensitive, possibly impacting local fisheries. Others do not respresent significant environmental concerns.

The Wynoochee Dam is an example of the latter. The dam has already been built, and the environmental damage done. The Army Corps of Engineers, together with Grays Harbor PUD, is considering a power generation retrofit for Wynoochee. One concern over the power retrofit has been an effort to retrofit fish ladders at the same time. Council action may be the best available means to resolve this concern, and move the project ahead.

Wynoochee happens to have its peak outflow during the Winter. Grays

TABLE 8

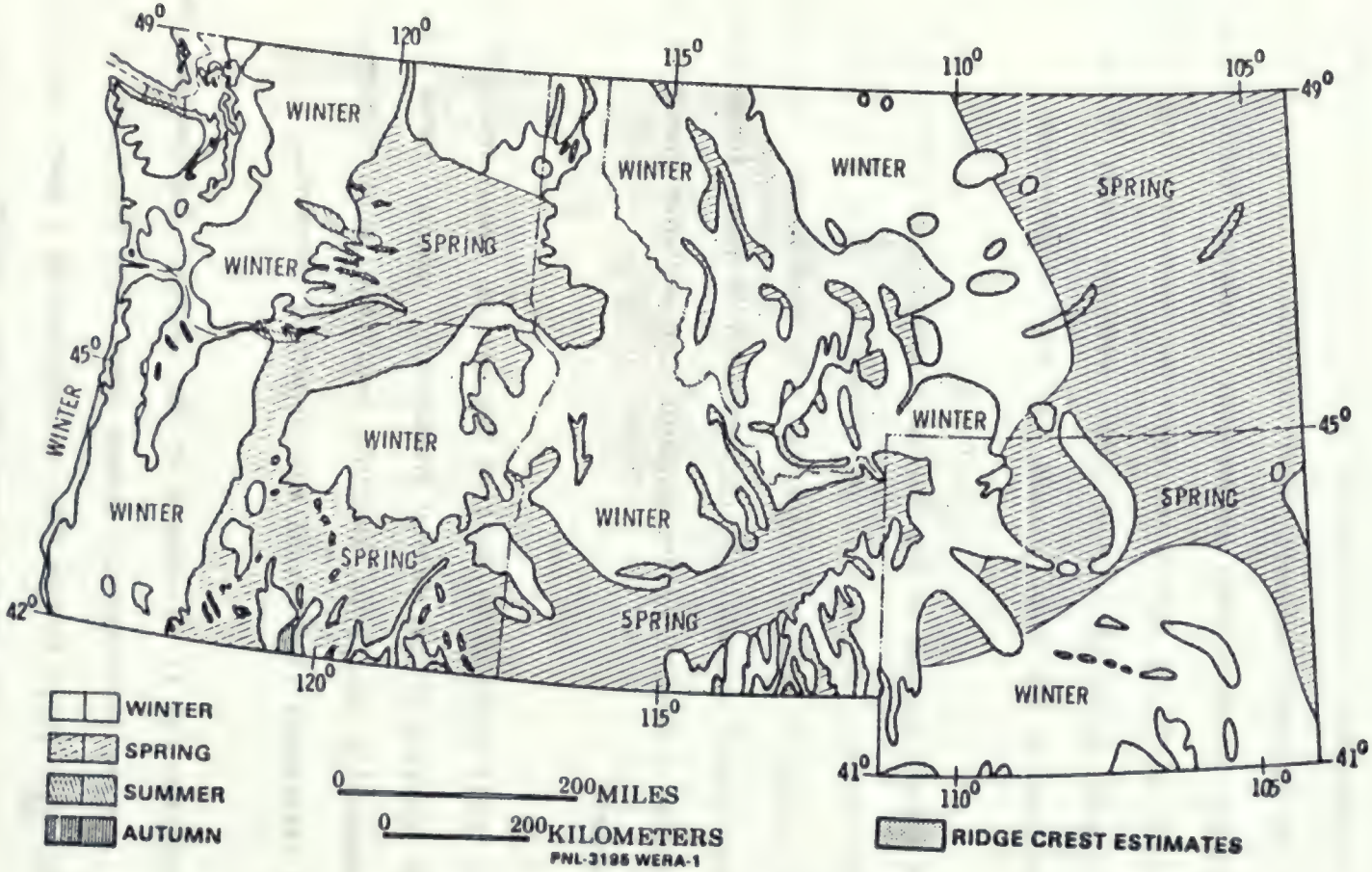


FIGURE 2.5. Seasonal Maximum Wind Power in the Northwest

TABLE 9

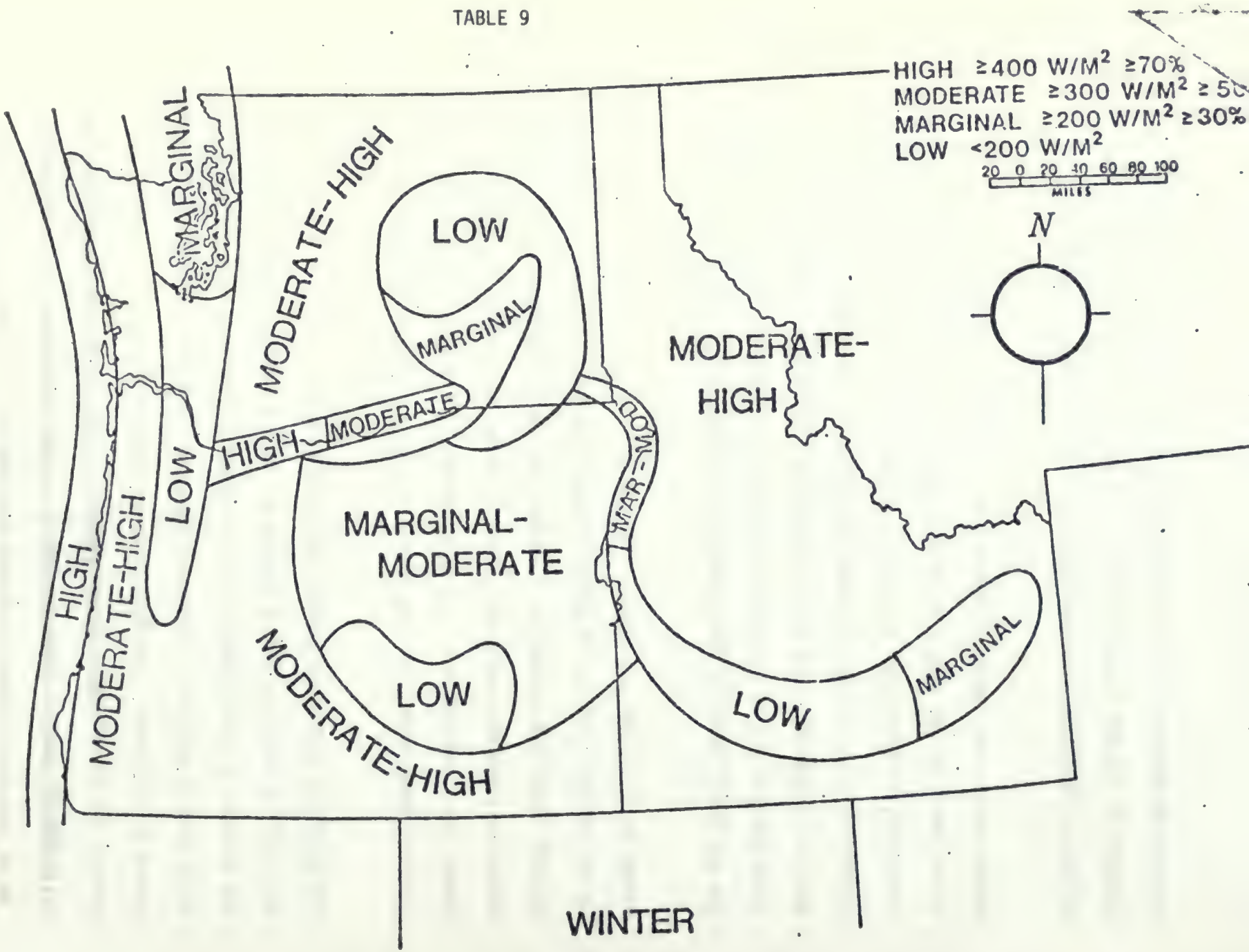


Figure 3. Effective power density map [illegible] inter.

Harbor County's marine climate brings large amounts of rainfall during the Winter. Retrofit of the dam with generation would allow this to be harnessed. As indicated on Table 6, the Wynoochee pattern is typical of the Olympic peninusla and South Puget Sound areas.

ELECTRIC FURNACE BUY-BACK PROGRAM

While perhaps not strictly considered a conservation measure, the use of natural gas to replace an existing Winter electricity use does effectively reduce Winter loads. The particular use considered here is residential space heating employing forced-air electric furnaces. In order to estimate the economic attractiveness and load reduction potential of fuel switching this use, we have analyzed a program of "buying-back" electric furnaces and replacing them with natural gas fired models.

For each house converted, the annual savings of electricity equals the annual space heating use. The total number of candidate houses equals the number of northwest electrically heated homes equipped with a forced-air furnace system and located on a natural gas main. The cost per conversion is the capital cost of the furnace change and gas hook-up plus the added annual cost, if any, of natural gas use.

The BPA Draft Technical Assessment of Conservation Potential gives the average space heating use in electrically heated single family homes in the northwest as 13,634 kwh. The Pacific Northwest Residential Energy Survey completed recently for BPA indicates that 6.4% of all northwest homes are electrically heated with forced-air furnaces and are located on gas mains. On the basis of the number of single family electric customers in the West Group region, our canditate population is 156,000 homes.

Based on discussion with Washington Natural Gas Company, we have taken $900 as an average conversion cost. To this is added an annual cost of $15 for maintenance. The price difference for gas and electric space

heating was computed on the basis of rates in effect as of November 1981 for five different pairs of electric and gas utilities. Table 10 identifies these utilities by representative location and gives the current additional cost (or savings) of using gas. These amounts were computed by using the average base household electric load given in the BPA Draft Technical Assessment and assuming a 70% seasonal efficiency for the new gas furnace installed. Appendix presents the full seasonal rate calculations. The seasonal heating fractions used are typical of Yakima, which appears to approximate the average northwest climate.

TABLE 10

Location	Electric Utility	Natural Gas Utility	Added Cost of Gas Heating
Seattle	Seattle City Light	Washington Natural Gas	$152.63
Bellevue	Puget Sound Power & Light	Washington Natural Gas	61.86
Yakima	Pacific Power & Light	Cascade Natural Gas	12.84
Spokane	Washington Water Power	Washington Water Power	14.72
Portland	Portland General Electric	Northwest Natural Gas	-116.75

We have computed an effective cost of saving this electricity via this furnace buy-back program by adding the 20 year annual financed cost of the conversion to the annual added fuel and maintenance costs. Divided by the annual kwh savings, this yearly cost equals the price per kwh saved. Using BPA's current financing rate of 13%, the kwh cost of this load reduction ranges from a high of 21 mills per kwh for Seattle City Light through 14 and 10 mills for Washington investor-owned utility customers to less than 1 mill for Portland General Electric customers. Even the highest of these figures

is much less than the cost of new electric resources. The lower cost figures represent a bargain with respect to even most conservation measures suggested.

Conversion of the total sample of 156,000 homes would yield an annual electrical savings of 2.1 billion kwh. 92% of this amount would be saved during the period October through April, allowing storage for May fish enhancement release. The October-April total savings are approximately 2,700 MW-months. The added natural gas load resulting from this program equals 96 million therms. This is only 6.3% of total 1980 natural gas sales in Washington alone and much less than the price induced sales decline that the region's gas utilities have experienced in recent years. There appears to be no difficulty in supplying the natural gas needed to offset the electric load reduction.

As large as these savings are, they do not include additional savings that might be obtained by expanding the program to include houses not now on gas mains and not equipped with forced-air systems. While these classes of conversions would entail slightly higher costs, the cost of electricity saved would still be very low compared to new generation. Similarly there is probably additional large conversion potential in the industrial and commercial sectors, some of which is Winter peaking.

To prevent erosion of these savings due to the use of electric heating in new homes, some mechanism should be established to prohibit or persuade builders from adding electric heat to new construction.

EXCHANGE OF EXCESS GENERATION WITH CALIFORNIA

In past years, it has been possible to send excess generation which has resulted from fish flow releases to California, on a provisional return basis. The arrangement has typically been that if Northwest reservoirs refill, the energy is treated as a secondary sale, while if our reservoirs do not refill, the energy is to be returned.

Such an arrangement has been made in the past, with a total of 465 Gwh having been sent from the NW to the SW in 1977/78 and 1979/80. Of this amount, only 95 Gwh was recalled, meaning that the California utilities benefitted to the amount of approximately 370 Gwh, sufficient to displace approximately 25 million gal of oil, improving the nation's balance of payments by about $25 million at today's oil prices. In 1977/78, heavy rains in the Fall made spills necessary at some power stations; had the "fish water" not been sent South in the Spring, it is likely that greater spills would have been required, and the water would have been wasted.

California utilities appear to be willing to undertake negotiations to provide for return of provisional energy made available by "fish water" releases. Their concern falls into three categories:

1) That they not be obliged to return energy which could not have been stored in the Northwest, thereby essentially converting "June" secondary energy into "May" storage exchanges.

2) That fluctuations in oil prices between the time of receipt and the time of return be covered by the Northwest.

3) That they not be required to return energy until after October 15, the close of their air-conditioning season.

The first and third of these concerns should not be of any concern to the Northwest. So long as they are only obliged to return that energy which but for fish flows would have been stored for regional use, the NW does not lose any generation which could have been used here. At the same time, since years like 1977 and 1981 do occur, where heavy Summer or Fall rains make returns unnecessary, in spite of below-rule curve reservoir levels in the previous Spring, such an arrangement may provide for the sale of secondary which otherwise might have had to have been spilled. The experience in these recent years, when additional provisional sales to California would have resulted in greater revenues to the Northwest, lesser use of oil for California generation, and lower rates to both NW and SW ratepayers, has given SW utility officials the confidence they need to enter into provisional "fish water" storage exchange agreements with the NW.

To deal with the first concern, unless a firm storage exchange can be arranged with a Southwest utility, it seems reasonable to allow the SW what it wants... the opportunity to purchase as secondary energy the power produced during "fish water" transactions in years where Northwest reservoirs subsequently do refill. The arrangement they offer is advantageous to the Northwest, since it gives us the opportunity to sell energy, with an assurance of return if it turns out we could have stored the energy. The cost to the Northwest in dry years is essentially the losses associated with two way transmission on the AC or DC interties. An estimate of the value of energy sales, and the cost of losses, is provided in the appendix to this report.

The second concern, that the NW absorb any fluctuations in prices for oil between the time of deliver of energy from the NW, and the time of return to the NW, is an issue which needs to be negotiated. The California concern

stems from problems encountered in recent years, notably 1979/80, when the price of oil skyrocketed, due to the Iran crisis, resulting in a need to return energy which cost substantially more to produce than the energy displaced by the Spring "fish water" energy receipt would have cost. The result was greater cost to their customers than would have been the case if the storage transaction had not taken place. This concern is mitigated, in part, by the fact that we can provide the SW with energy at a high load factor in Spring, displacing inefficient generating plants during the day, and more efficient plants during off-peak hours. On the other hand, we can accept return of the energy during off-peak hours in October, November, and December, allowing them to return the energy using fewer bbls of oil than we initially displaced. The NW should take a tough bargaining stance on this issue; we may have to accept the risk of oil PRICE changes, but that should be offset by oil QUANTITY savings.

The third concern of California, that they not be asked to return energy until after October 15, should be a welcome offer to the NW. Based on the 1981 West Group Forecast, November and December loads are significantly higher than September and October loads. Having the energy returned to us during a period when loads are high helps to offset a load which would otherwise require either additional hydro storage, or the use of thermal resources in the Northwest, with their high attendant costs. The NW may want to negotiate to have returns take place specifically during high load off-peak hours in December/January. Our high load factors (daily) during the Winter, due to electric heat saturation, would allow the NW to use off-peak energy from California to allow reservoir levels in run-of-river plants to build up, providing additional head, and increased peaking capacity. So long as minimum flow requirements were met, which is likely during particularly cold periods, significant economic savings could be enjoyed. Negotiations for return of "fish water" storage could prove very attractive for both the NW and the SW.

ECONOMIC COSTS OF "WORST CASE" MITIGATION MEASURES

This analysis of the cost of providing the modifications for fishery migration contained in the "V" computer run of the Army Corps of Engineers hydro model makes numerous assumptions regarding the cost of energy, the value of secondary energy, and the probability of reservoir refill. These derive from various sources.

The cost of new energy, on an annual basis, is presumed to be 65 mills/kwh at the generating plant. This is approximately the midpoint of two recent analyses, and approximates the cost, in 1981 dollars, of power from WPPSS units 4&5.[4]

Secondary energy is assumed to be priced at 30 mills/kwh in the ten driest years of the 40 year water study, which this report evaluates as those most likely to involve adverse fish migration opportunities. It is common in wet years for secondary to be priced much lower, but in dry years a premium price is obtainable, and has been assumed. 30 mills is approximately a "split-the-savings" rate, between the incremental cost of NW generation, and the decremental cost of SW generation from oil and gas.[5] While an actual price would have to be negotiated for the sale of "fish water" energy, our discussions with SW utilities have indicated that such a price may be reasonably obtainable, provided that other concerns they have are met.

The loss of an average of 35 MW of generation is a cost of reregulation of the hydro system which must be assigned to the fishery enhancement program. 19 of this is additional spill, required to maintain adequate flows. The remainder is due to the fact that reregulation generally creates a situation where reservoirs are not kept as full as would present regulations.

Lower heads result in less power being generated from available streamflows. The loss of this 35 average MW -ust be considered a "cost" of returning the river to multiple use. At 65 mills, the annual average we have used in this analysis, this amounts to $19.9 million per year.

It should be pointed out, however, that the revisions contained in run "V" cause the hydro system to produce a greater amount of energy, on average, in the driest years of operation. Specifically, in the seven driest years of the 40 year water study, an average of 69 average MW of energy is produced above the expected generation under current regulation. Since these driest years are the most likely years for operation of oil fired powerplants to meet regional load, this additional generation will save expensive fuel. Assuming that generation from residual oil fired plants in California is available, savings of 1 million bbl of oil can be anticipated in these dry years, valued at $40 million. If combustion turbine generation would be required in the absence of this generation, higher costs would be incurred. This could tend to mitigate, economically, much of the extra cost associated with the net loss of generation over the 40 year water study, some 35 MW on average.

A large portion of this 35 MW loss could be eliminated by the installation of additional generation at Dworshak dam in Idaho. During dry years, regulation "V" drafts substantial amounts of water from Dworshak in April and May. Much of this must be spilled, due to limited generating capability. The 1981 PNUCC forecast shows an additional 220 MW generator to come on line at Dworshak beginning in 1987. This would allow substantially all of the proposed spill to be generated instead. Since this additional generation would be occurring in the Spring, we have assumed that it will be sold at secondary rates. In actuality, it may be possible to store this

generation with California utilities, subject to recall in the event that NW reservoirs do not refill. If this were achievable, it would significantly reduce costs below those estimated herein.

We stress that this is a "worst case" estimate. If water were available from uncontracted irrigation reserves, the spillage at Dworshak would be reduced or eliminated. If load shifting results from the implementation of conservation strategies, or the development of load-matched resources, costs are similarly eliminated.

The strategy used in this analysis to compensate the region for generation rescheduling caused by regulation of the hydro system for multiple uses centers on storage of surplus Spring generation during dry years with Southwest utilities, subject to recall. This strategy is discussed at length under "Exchange of Excess Generation With California." BPA has used such an approach at least twice in the past, in 1977 and 1980.[6]

In eight of the ten driest years of record, we have assumed that all of the energy generated in excess of that which would be developed under present regulation would be transmitted to California during April and May, but recalled in October through December. This recall is acceptable to system dispatch needs in California, and allows the NW to rebuild reservoir heads in anticipation of Winter peaking needs. During two dry years of the ten, we have assumed that recall would not turn out to be appropriate, due to successful refill of Northwest reservoirs. It is this potential of obtaining secondary energy in April and May, which would otherwise have had to be spilled in late Summer, which makes the exchange program attractive to California. Basically, this feature makes it a "no-lose" proposition to the Southwest. This is consistent with our "worst case" approach. A

strong negotiating posture with California utilities could hold costs well below the levels we have calculated.

In years when energy is to be recalled from California, the NW must absorb the transmission losses in both directions, to avoid adverse cost impacts to California. At 15%, this amounts to about 96,000 Mwh, or $6.2 million per year. Over the eight dry years, the total cost of these losses is $49.8 million. During two of the ten, we have assumed that the system will refill, and that the energy sent to California in April and May will be sold at secondary rates. This is in addition to any secondary which becomes available at Dworshak, after the installation of unit #4, as discussed earlier.

At 30 mills, the 638,640 Mwh sold in each of these years will bring in revenue of $19.16 million. This should properly be offset against the cost of the proposed revision to hydro regulation, bringing the net cost for the ten driest years to $11.5 million for the power exchange. On an annual basis, over the full 40 year water study, the cost of the "fish water" exchange is thus only $287,500 per year, a minimal cost to ratepayers.

The value of the secondary sold as a result of system refill in two of the driest years is propserly credited against regulation of the river for fish enhancement for one simple reason. If early reservoir drafts were not made in these year, late runoff would result in reservoir spill. Under present regulations, as observed in both 1977 and 1981, late runoff did result in spills. If reservoirs had been provisionally drafted, to provide more adequate fish migration opportunities, the later runoff could have been captured and used for power purposes. As it was, the water in those years was wasted.

The cost of the "fish water" exchange with California must be added to the replacement cost of the reduced average generation from reregulation, including additional spill. The total annual cost of the proposed strategy for reregulation, under this "worst case" scenario, is thus $18.2 million. It is this figure which can be compared with the economic benefits of enhanced fisheries from more balanced river management.

WORST CASE ANALYSIS

ECONOMIC COSTS OF FISH EXCHANGE MITIGATION

35 Average MW reduction in hydrogeneration (Run "F" vs Run "V")

306,600 MwH @ 65 mills/kwh	$19.9 million/yr
Less: 8 Average MW additional secondary from Dworshak #4, scheduled on-line 1987	
70,080 MwH @ 30 mills/kwh	$2.1 million/yr
Total cost of generation reduction:	$17.9 million/yr

Cost of "Fish Water" power exchange with California

Average increase in Spring generation (10 driest years of record) is 887 MwMo, or 638,640 MwHr.

In 8 years out of ten driest, assume energy must be returned;
In 2 years out of ten driest, assume that the system refills, and energy can be sold as secondary.

8 years,	15% losses must be absorbed in-region: 95,976 MwHr @ 65 mills/kwh	$6.226 million/yr	$49.8 million
2 years	Energy is sold as secondary 638,640 MwHr @ 30 mills	$19.16 million/yr	($38.3 million)
	Total cost of exchange in ten driest years:		$11.5 million

Modified operation of reservoirs does not significantly affect refill probabilities in 30 normal and wet years of water study

Weighted average cost of reservoir regulation modifications is thus $11.5 million/40 years: $287,500/yr.

Total cost of fish migration revisions: $18.2 million/yr.

FOOTNOTES

1 See: Public Utility Commissioner of Oregon, West Group Forecast Analysis, T. Zepp, 1979

Also: Choosing and Electrical Energy Future for the Pacific Northwest, Natural Resources Defense Council, 1980

2) Pacific Gas and Electric Co., Status of Residential Elasticity Studies, 1980

3) Whittlesey, N.K. et. al., Energy Tradeoffs and Economic Feasibility of Irrigation Development in the Pacific Northwest, College of Agriculture Research Center, Washington State University, 1981

4) See: Comments on BPA Billing Credit Program, Natural Resources Defense Council (84 mills), 1981,

Also: Long Run Incremental Cost Analysis, Bonneville Power Administration, 1980 (43 mills)

5) See: Hypothetical Markets for Import and Export of Electricity from the Pacific Northwest, Dames and Moore, 1981 at P. 11

6) See: Interregional Resource Potentials, BPA, June, 1981

APPENDIX

SEATTLE CITY LIGHT	BASE	TO 300.	TO 480.	ABOVE 480.	KWH
	0.00	.7800	1.7500	1.7500	SUMMER
	0.00	.8600	.8600	2.3000	WINTER

WASHINGTON NATURAL GAS	BASE	TO 0.	TO 25.	ABOVE 25.	THERMS
	4.50	0.0000	65.2500	54.1600	

MONTH	FRACTION OF ANNUAL LOAD	KWH BASE	DOLLARS	KWH HEATING	DOLLARS	THERMS HEATING	DOLLARS
JAN	.196	910.	14.02	2672.	61.46	130.3	77.84
FEB	.146	910.	14.02	1991.	45.78	97.1	59.84
MAR	.120	910.	14.02	1636.	37.63	79.8	50.48
APR	.073	910.	13.02	995.	17.42	48.5	33.56
MAY	.037	910.	13.02	504.	8.83	24.6	20.55
JUN	.012	910.	13.02	164.	2.86	8.0	9.71
JUL	0.000	910.	13.02	0.	0.00	0.0	4.50
AUG	.002	910.	13.02	27.	.48	1.3	5.37
SEP	.024	910.	13.02	327.	5.73	16.0	14.91
OCT	.076	910.	13.02	1036.	18.13	50.5	34.64
NOV	.139	910.	13.02	1895.	33.16	92.4	57.32
DEC	.175	910.	14.02	2386.	54.88	116.3	70.28
TOTAL	1.000	10920.	160.19	13634.	286.36	664.8	438.99

PUGET SOUND POWER & LIGHT

BASE	TO 400.	TO 1500.	ABOVE 1500.	KWH
3.45	2.1988	2.3133	2.6886	SUMMER
3.45	2.1988	2.5446	2.9575	WINTER

WASHINGTON NATURAL GAS

BASE	TO 0.	TO 25.	ABOVE 25.	THERMS
4.50	0.0000	65.2500	54.1600	

MONTH	FRACTION OF ANNUAL LOAD	KWH BASE	DOLLARS	KWH HEATING	DOLLARS	THERMS HEATING	DOLLARS
JAN	.196	910.	25.22	2672.	76.60	130.3	77.84
FEB	.146	910.	25.22	1991.	56.43	97.1	59.84
MAR	.120	910.	25.22	1636.	45.95	79.8	50.48
APR	.073	910.	24.04	995.	24.54	48.5	33.56
MAY	.037	910.	24.04	504.	11.67	24.6	20.55
JUN	.012	910.	24.04	164.	3.78	8.0	9.71
JUL	0.000	910.	24.04	0.	.00	0.0	4.50
AUG	.002	910.	24.04	27.	.63	1.3	5.37
SEP	.024	910.	24.04	327.	7.57	16.0	14.91
OCT	.076	910.	25.22	1036.	28.21	50.5	34.64
NOV	.139	910.	25.22	1895.	53.61	92.4	57.32
DEC	.175	910.	25.22	2386.	68.13	116.3	70.28
TOTAL	1.000	10920.	295.59	13634.	377.13	664.8	438.99

PACIFIC POWER & LIGHT

BASE TO 0.	TO 0.	ABOVE 0. KWH
3.45	0.0000	0.0000	2.5610

CASCADE NATURAL GAS

BASE TO 0.	TO 50.	ABOVE 50. THERMS
1.20	0.0000	53.7060	50.1670

MONTH	FRACTION OF ANNUAL LOAD	KWH BASE	DOLLARS	KWH HEATING	DOLLARS	THERMS HEATING	DOLLARS
JAN	.196	910.	26.76	2672.	68.44	130.3	68.34
FEB	.146	910.	26.76	1991.	50.98	97.1	51.66
MAR	.120	910.	26.76	1636.	41.90	79.8	42.99
APR	.073	910.	26.76	995.	25.49	48.5	27.26
MAY	.037	910.	26.76	504.	12.92	24.6	14.41
JUN	.012	910.	26.76	164.	4.19	8.0	5.48
JUL	0.000	910.	26.76	0.	.00	0.0	1.20
AUG	.002	910.	26.76	27.	.70	1.3	1.91
SEP	.024	910.	26.76	327.	8.38	16.0	9.77
OCT	.076	910.	26.76	1036.	26.54	50.5	28.32
NOV	.139	910.	26.76	1895.	48.53	92.4	49.33
DEC	.175	910.	26.76	2386.	61.10	116.3	61.33
TOTAL	1.000	10920.	321.06	13634.	349.17	664.8	362.01

WASHINGTON WATER POWER (E) BASE TO 600. TO 1300. ABOVE 1300. KWH
2.80 1.6500 1.8200 2.2200

WASHINGTON WATER POWER (G) BASE TO 0. TO 0. ABOVE 0. THERMS
2.80 0.0000 0.0000 40.5000

MONTH	FRACTION OF ANNUAL LOAD	KWH BASE	DOLLARS	KWH HEATING	DOLLARS	THERMS HEATING	DOLLARS
JAN	.196	910.	18.34	2672.	57.76	130.3	55.57
FEB	.146	910.	18.34	1991.	42.63	97.1	42.11
MAR	.120	910.	18.34	1636.	34.76	79.8	35.11
APR	.073	910.	18.34	995.	20.54	48.5	22.45
MAY	.037	910.	18.34	504.	9.64	24.6	12.76
JUN	.012	910.	18.34	164.	2.98	8.0	6.03
JUL	0.000	910.	18.34	0.	.00	0.0	2.80
AUG	.002	910.	18.34	27.	.50	1.3	3.34
SEP	.024	910.	18.34	327.	5.96	16.0	9.26
OCT	.076	910.	18.34	1036.	21.44	50.5	23.26
NOV	.139	910.	18.34	1895.	40.51	92.4	40.22
DEC	.175	910.	18.34	2386.	51.41	116.3	49.92
TOTAL	1.000	10920.	220.10	13634.	288.12	664.8	302.84

PORTLAND GENERAL ELECTRIC BASE TO 700. TO 2300. ABOVE 2300. KWH
3.00 2.7857 3.7500 4.5000

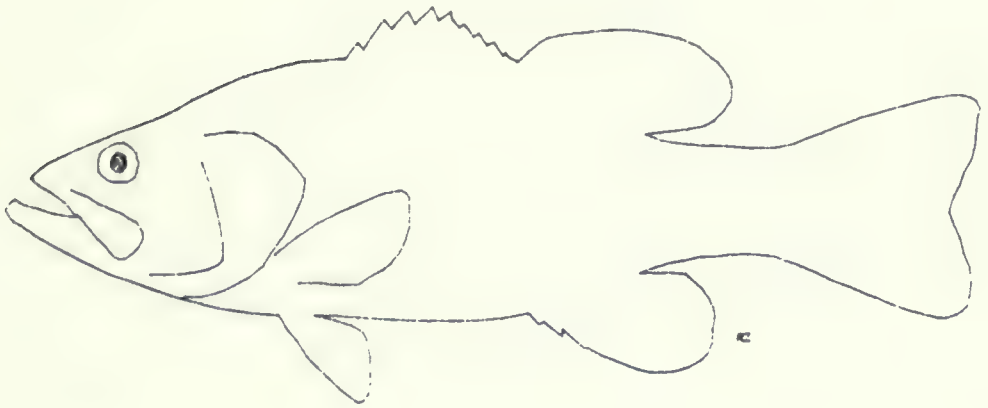
NORTHWEST NATURAL GAS BASE TO 0. TO 0. ABOVE 0. THERMS
2.50 0.0000 0.0000 58.9280

MONTH	FRACTION OF ANNUAL LOAD	KWH BASE	DOLLARS	KWH HEATING	DOLLARS	THERMS HEATING	DOLLARS
JAN	.196	910.	30.37	2672.	109.83	130.3	79.28
FEB	.146	910.	30.37	1991.	79.15	97.1	59.70
MAR	.120	910.	30.37	1636.	63.20	79.8	49.51
APR	.073	910.	30.37	995.	37.32	48.5	31.10
MAY	.037	910.	30.37	504.	18.92	24.6	16.99
JUN	.012	910.	30.37	164.	6.14	8.0	7.20
JUL	0.000	910.	30.37	0.	0.00	0.0	2.50
AUG	.002	910.	30.37	27.	1.02	1.3	3.28
SEP	.024	910.	30.37	327.	12.27	16.0	11.90
OCT	.076	910.	30.37	1036.	38.86	50.5	32.27
NOV	.139	910.	30.37	1895.	74.86	92.4	56.95
DEC	.175	910.	30.37	2386.	96.94	116.3	71.06
TOTAL	1.000	10920.	364.50	13634.	538.50	664.8	421.75

RESIDENT FISH

INITIAL RECOMMENDATIONS FOR THE PROTECTION, MITIGATION, AND ENHANCEMENT OF RESIDENT FISH IN THE COLUMBIA RIVER BASIN

Submitted in accordance with Sec. 4(h) of the Pacific Northwest Electric Power Planning and Conservation Act by:



THE U.S. FISH AND WILDLIFE SERVICE

THE WASHINGTON DEPARTMENT OF GAME

THE OREGON DEPARTMENT OF FISH AND WILDLIFE

THE IDAHO DEPARTMENT OF FISH AND GAME

THE MONTANA DEPARTMENT OF FISH, GAME, AND PARKS

RECOMMENDATIONS PERTAINING TO RESIDENT FISH IN THE COLUMBIA BASIN

A Report To The
Northwest Power Planning Council
November 13, 1981

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INTRODUCTION

The Pacific Northwest Power Planning and Conservation Act of 1980 (Public Law 96-501), which established the Power Planning Council (PPC), provided for the promot development and adoption of a program to protect, mitigate, and enhance fish and wildlife resources on the Columbia River and its tributaries. The PPC requested on June 10, 1981, the appropriate Federal and State fish and wildlife agencies and Indian Tribes of the region to develop measures and objectives to be implemented for development and operation of projects, and to coordinate management, research, and development programs to protect, mitigate, and enhance the fish and wildlife resources. This report addresses the resident fish component of this request by the PPC with additional reports addressing the anadromous fish and the wildlife components also being submitted.

The Columbia Basin Resident Fish Technical Committee (CBRFTC), which prepared this report, evolved from the resident fish subcommittee of the Pacific Northwest River Basins Commission. Originally the committee was asked to prepare a report dealing with the issues and problems confronting resident fish and to demonstrate the recreational value of the resource for the Pacific Northwest River Basins Commission.

The Ad Hoc Executive Committee for Power Act coordination narrowed the scope to address the impacts power development and its operation have on resident fish. A formal structure for the CBRFTC, mission, goal, objectives, and membership were adopted by the Ad Hoc Executive Committee July 27, 1981. The U.S. Fish and Wildlife Service was designated the lead agency coordinating the efforts with the recommendations and supporting evidence developed for each State by the agency responsible for managing the resource: Montana Department of Fish, Wildlife, and Parks (Appendix A); Idaho Department of Fish and Game (Appendix B); Washington Department of Game (Appendix C); and Oregon Department of Fish and Wildlife (Appendix D).

SCOPE

Resident fishes inhabit all the waters in the 219,400 square mile Columbia Basin. For this report, the waters and fishes affected by presently operating power plants received the major emphasis with a few general recommendations identifying factors to be considered if future projects are developed.

The species of game fish referred to in this report may be categorized as coldwater, coolwater, and warmwater species. Coldwater species are kokanee (Oncorhynchus nerka), cutthroat (Salmo clarki), rainbow (S. gairdneri), brown (S. trutta), bull/Dolly Varden (Salvelinus confluentus), and brook trout (S. fontinalis), and mountain whitefish (Prosopium williamsoni). Coolwater species are smallmouth bass (Micropterus dolomieui), walleye (Stizostedion vitreum), and yellow perch (Perca flavescens); warmwater species are largemouth bass (Midropterus salmoides), channel catfish (Ictalurus punctatus), bullheads (I spp.), sunfishes, (Lepomis spp.), and crappies (Pomoxis spp.). Two anadromous species, white sturgeon (Acipenser transmontanus) and American shad (Alosa sapidissoma) were also included in this report since many of their life history requirements are more comparable with resident fishes than with the salmonids discussed in the anadromous fish report. In addition to these desirable species for which the State agencies manage the waters, various nongame species are present. The nongame species of particular concern referred to include; carp (Cyprinus carpio), northern squawfish (Ptycheilus oregonensis), and suckers (Catostomus spp.).

The recommendations presented are of three types: (1) Modification of present operational regimes; (2) Continuation of existing constraints on a projects operational regime; and (3) Studies to provide biological data for scientific management of the resource. The first type of recommendations are primarily targeted at projects not included in the anadromous fish report. Rather than duplicate the recommendations on flows included in the anadromous fish report, the resident fish committee endorses these recommendations since they would also benefit resident as well as anadromous species. The second type of recommendations apply to constraints originally placed on a project to protect or enhance the resident fishery, and if they have been successful they are recommended to continue. The third type of recommendations are concerned with funding studies to obtain information required to develop plans for scientifically managing a resource under the present conditions imposed or created by operation of the power system. Cost estimates of the recommendations could not be made since the committee did not have the expertise or data to compute potential power revenues which may be lost or the extent of the studies required to provide the necessary data.

The evidence to support these recommendations was prepared by each State (Appendices A to D). The supporting documents prepared by the State of Montana (Appendix A) also include recommendations pertaining to wildlife resources and those prepared by the Confederated Salish and Kootenai Tribes. However, these recommendations are not included in the next section. The watersheds, power projects, historical and present fishery resource, and fishery management plans are reviewed. Since the construction/operating agencies failed to fund pre-project inventories, the pre-project extent of the resource and public use could not be quantified but only described as to quality. In fact, current data are generally lacking at most projects as to the present extent of the resource so only general statements regarding the quality of the fishery could be made as to the deliterious or beneficial impacts that resulted from the construction/operation of a project.

RECOMMENDATIONS FOR RESIDENT FISH

GOAL: RESTORE AND PROTECT TO THE GREATEST EXTENT POSSIBLE THE RESIDENT FISHERY RESOURCE IMPACTED BY THE DEVELOPMENT AND OPERATION OF THE COLUMBIA RIVER BASIN POWER SYSTEM.

OBJECTIVE 1: REPRODUCTION AND REARING

Restore and protect suitable habitat for spawning, incubation, emergence, and rearing to provide adequate recruitment for maintaining resident sport fish populations at levels needed to meet public demand.

1.1 Reservoir Discharge: Maintain desirable stream flow to ensure successful reproduction and rearing.

MONTANA

1.1.1 Hungry Horse Dam should be operated to ensure successful reproduction of kokanee in the Flathead River as follows (Appendix A, p. 19):

Spawning - Flow at Columbia Falls should not be less than 4,000 cfs and not more than 4,500 cfs between the hours of 1700 and 2400 throughout the month of November. From 2400 to 1700 hours, the flow may exceed 4,500 cfs but should never be less than 2,500 cfs.

Incubation- A minimum flow of at least 2,500 cfs at Columbia Falls should be maintained 24 hours per day from December 1 through March 31.

Emergence - A minimum flow of not less than 4,000 cfs at Columbia Falls should be maintained 24 hours per day from April 1 until combined flows of the North and Middle Fork Flathead Rivers exceed 4,000 cfs.

1.1.2 A minimum flow of at least 2,500 cfs in the Flathead River at Columbia Falls should be maintained 24 hours per day from July 1 through October 31 (Appendix A, p. 21).

1.1.3 Effects of amount and timing of controlled discharges from Hungry Horse Dam on distribution and migration of kokanee spawners in the Flathead River should be quantified (Appendix A, p. 23).

1.1.4 To meet the management goal of improving kokanee reproductive success and the kokanee snag fishery in the Swan River, it is necessary to investigate past mitigation attempts and operations of Big Fork Dam to determine if present practices should be continued, altered, or abandoned. Specific objectives include (Appendix A, p. 31):

1. Document the effect a minimum flow of 20 cfs has on successful reproduction and incubation of kokanee salmon.

2. Document the effect a surge flow of 150-250 cfs, during the hours of 2:00 am to 6:00 am two or three days a week, has on mitigation, spawning, and incubation success of kokanee.

3. Continue the practice of adding spawning-sized gravel downstream from Big Fork Dam and document if kokanee reproductive success is improved by this method.

4. Document if kokanee (or other fish) recruitment downstream out of Swan Lake is prevented by diversion through the Big Fork powerhouse and investigate appropriate measures to reduce entrainment (if needed).

1.1.5 Maintain the present minimum flow of 40 cfs between Big Fork Dam and the powerhouse and document if this flow is sufficient to ensure successful reproduction and rearing of resident species such as rainbow trout (Appendix A, p. 32).

WASHINGTON

1.1.6 The following recommended Yakima River Basin streamflows, largely regulated by USBR reservoir discharge would be possible in large part with 1.8.17 (enlarged Bumping Reservoir) and should be strived for. Reservoir discharge should not be regulated for new and future hydro-generation at the expense of fishery needs (Appendix C, p. 33).

Yakima River	Ootimum (cfs)	Minimum (cfs)
At Martin	100	35
" Easton	285	95
" Cle Elum	625	210
" Umtanum	730	240
" Pomona	730	240
" Yakima	1260	420
" Parker	1355	450
" Prosser	1685	560
" Kiona	1680	560
Kachess River		
At Easton	90	30
Teanaway River		
At Forks	100	35
Cle Elum River		
At Roslyn	280	95
Bumping River	90	30
Naches River		
Above Tieton River confl.	365	120
Below Tieton River confl.	530	180
Tieton River		
Below Rimrock Reservoir	150	50
Below diversion	170	55

1.2 Reservoir Operation: Maintain reservoirs within desirable vertical limits to ensure successful reproduction and rearing.

MONTANA

1.2.1 Drawdown of Hungry Horse Reservoir should not exceed 35 feet (Appendix A. p. 25).

1.2.2 Results from a recently initiated kokanee study should be evaluated to determine measures which could be implemented to improve reproductive success of kokanee in Flathead Lake and provide a good lakeshore snagging fishery (Appendix A, p. 39).

1. Investigate the effect of operation of Kerr and Hungry Horse dams on water levels in Flathead Lake and quantify effect of amount and timing of drawdown on distribution and reproductive success of kokanee spawning on Flathead Lake.

2. Delineate extent of successful shoreline spawning in Flathead Lake both on-shore (less than 20 feet in depth) and off-shore (greater than 20 feet in depth).

3. Quantify influence of ground water on incubation success of on-shore spawners in Flathead Lake subject to dewatering by lake drawdown.

1.2.3 To maintain habitat conditions suitable for the survival of salmonids in Georgetown Lake, future operations of the Flint Creek Project should not be altered from past practices without considering and incorporating the needs of the fishery in those plans (Appendix A, p. 62).

1.2.4 Upon completion of the long-range planning process for Milltown Dam in 1982, a study should be conducted to evaluate the impacts of Montana Power Company's recommendation on suspended sediments, heavy metals, fish abundance and growth, and probably macroinvertebrate populations. The evaluation should determine if the measures recommended adequately protect the fishery resource downstream from the project (Appendix A, p. 65).

1.2.5 Existing constraints on operations of Libby Dam for fisheries should be maintained (Appendix A, p. 101).

1.2.6 Effects of Libby Dam operation on reproduction and rearing of white sturgeon in the Kootenai River should be assessed (Appendix A, p. 102).

IDAHO

1.2.7 Maintain operation of Post Falls Dam to minimize impacts on fishery resources (Appendix B, p. 6).

1.2.8 A study should be conducted by review all existing information to determine the relative role of the two hydroelectric facilities on the Pend Oreille system in declines of major sport species (Appendix B, p. 18).

1.2.9 The Boise River system is harnessed and controlled by a series of storage dams, diversion dams, and canals. A number of hydroelectric projects have been suggested at outlets, drains, and drop structures. Each new development will have some impacts on fishery resources and will require one or more of the following measures to mitigate or minimize impacts (Appendix B, p. 21):

1. Within the constraints of existing diversion and storage rights, instream flows sufficient to maintain aquatic resources should be provided.

2. Turbine intakes should be screened or game fish lost to turbine mortalities should be replaced.

3. Introductions of suitable species of game fish should be made as necessary to maintain sport fisheries in all waters affected by hydropower projects.

4. Habitat degraded by hydroelectric development should be restored or replaced.

WASHINGTON

1.2.10 To enhance successful reproduction and rearing, the water levels of mid-Columbia River reservoirs should fluctuate 2 feet or less in elevation, March through August (Appendix C, p. 10).

1.2.11 Rimrock Reservoir should not be drawn down below a minimum pool of 30,000 acre-feet, which is in addition to dead storage. Reservoir discharge should not be regulated for new and future hydro-generation at the expense of fish flow needs (Appendix C, p. 35).

1.2.12 Keechelus Reservoir should not be drawn down below a minimum pool of 25,000 acre-feet, which is in addition to dead storage. Reservoir discharge should not be regulated for new and future hydrogeneration at the expense of fish flow needs (Appendix C, p. 36).

1.2.13 The surface elevation of Banks Lake should be regulated for hydro-generation in accordance with the rule curves developed by Stober et al. (1977) to protect kokanee reproduction (Appendix C, p. 19)

1.2.14 To enhance and manage a significant fishery in mid-Columbia River reservoirs, the relationship between reservoir operations and fish survival, reproductive success, and production must be delineated. It is recommended that studies be initiated to: 1) assess the existing habitat suitability for spawning, rearing, food, and cover requirements and hydrological, limnological, and water quality conditions for species now present and those being considered for possible introduction; and 2) determine the most feasible methods to improve habitat suitability or increase habitat availability for desirable species considering particular species needs, project operations, costs, and other constraints (Appendix C, p.14).

1. Determine if food production is adequate to ensure sufficient survival and growth of gamefish in the mid-Columbia River reservoirs and if necessary, investigate methods to improve. Methods to increase food production may include stabilizing water levels to encourage establishment of a littoral zone, providing artificial substrate to increase food production, or other ways.

2. Identify areas and determine water levels necessary to provide spawning and rearing habitat for game species. A survey should be done to compare shoreline topography, water level fluctuations, and potential littoral development.

3. Delineate important reservoir and tributary spawning habitats and implement (if appropriate) measures to enhance gamefish reproductive success in mid-Columbia River reservoirs.

4. Determine if water quality in the mid-Columbia River reservoirs is adequate for survival, growth, and reproduction of desirable fish species.

OREGON

1.2.15 We would like the Power Planning Council to direct the operating agencies to review reservoir operations toward minimizing water level fluctuations (Appendix D, p. 2).

1.3 Instream Flows: Maintain stream flows within desirable limits to ensure successful reproduction.

MONTANA

1.3.1 Studies to determine instream flows adequate to ensure successful immigration, emigration, spawning, and rearing of rainbow and cutthroat trout to tributaries of the Kootenai River and Lake Koocanusa should be initiated (Appendix A, p. 101).

IDAHO

1.3.2 Guarantee instream flow minimums for overwintering and spawning trout in the South Fork below Anderson Ranch Dam (Appendix B, p. 21).

1.4 Water Temperature: Utilize storage to moderate temperature within desirable ranges.

1.5 Streambed Degradation and Sedimentation: Restore and protect bed material and reduce sedimentation in streams or reservoirs for betterment of reproduction and rearing.

MONTANA

1.5.1 Periodic removal of aggrading material in Kootenai River tributary deltas should be undertaken (Appendix A, p. 101).

1.6 Pollution

1.7 Productivity: Operate projects to minimize effects on primary and secondary productivity of streams and reservoirs.

MONTANA

1.7.1 To establish a significant fishery in the lower Clark Fork reservoirs, fish survival, reproductive success, and prodiction must be increased. It is recommended that a study be initiated to: 1) assess the existing habitat suitability for species now present and those designated for possible introduction. This would include spawning, rearing, food, and cover habitats and hydrological, limnological, and water quality conditions; and 2) determine the most feasible methods to improve habitat suitability or increase habitat availability for desirable species considering particular species needs, project operations, costs, and other constraints (Appendix A, p. 80).

1. Determine if food production is adequate to allow survival and growth of gamefish in the lower Clark Fork reservoirs and investigate ways to improve it (if necessary). Methods to increase food production may include stabilizing water levels along the shoreline to encourage establishment of a littoral zone, providing artificial substrate to increase insect production, or other techniques.

2. Identify areas and determine water levels necessary to provide rearing habitat and spawning for selected game species. A survey should be done to compare shoreline topography, water level flux, and potential littoral development.

3. Determine the potential of Marten Creek and Vermillion River as spawning streams and (if appropriate) provide access to spring spawning fish by maintaining water levels in Noxon Rapids Reservoir, constructing an access channel, or other methods.

4. Determine the importance of the 1.5 miles of river habitat below Thompson Falls Dam. This is the only remaining river habitat in the lower 80 miles of the Clark Fork River in Montana and may have potential as a spawning area for lake and mountain whitefish, brown trout, and other salmonids. Potential problems which must be addressed include scouring of suitable-sized gravel and maintenance of favorable spawning flows.

5. Delineate important spawning tributaries and determine and implement (if appropriate) measures to increase reservoir gamefish reproductive success in tributaries to Cabinet Gorge, Noxon Rapids, and Thompson Falls reservoirs.

6. Determine if water quality in the lower Clark Fork reservoirs is adequate for survival, growth, and reproduction of desirable fish species.

1.8 Alternative Measures: Mitigate loss of resident fish habitats by construction of hatcheries, spawning channels, use of other waters, etc.

MONTANA

1.8.1 Construction of a kokanee spawning channel in the South Fork Flathead River should be considered (Appendix A, p. 23).

1.8.2 Compensation for loss of a significant river fishery in the lower Clark Fork drainage should include enhancement of the Bitterroot River fisheries by purchasing rights to 95,000 acre-feet of water out of Pointed Rocks Reservoir from existing willing sellers for the purpose of providing instream flows during the summer and fall (Appendix A, p. 83).

1.8.3 The Council should consider the water needs of the fish and wildlife resources in the State of Montana and effects on these resources of any suggested changes in allocation of historical water storage for any downstream uses for power, flood storage, fish and wildlife, or other uses (Appendix A, p. 104).

IDAHO

1.8.4 Enhance the rainbow trout population of the Kootenai River by planting fingerling trout of a suitable stock for the river habitat (Appendix B, p 3).

1.8.5 Restore the sturgeon and ling population of the Kootenai River by implementing management programs recommended at the completion of the presently ongoing research project (Appendix B, p. 3).

1.8.6 Introduce chinook salmon and/or Kamloops rainbow trout as a pelagic predator in Lake Coeur d'Alene to provide a trophy fishery and to control overabundant kokanee (Appendix B, p. 6).

1.8.7 As recommended in 1950, hatchery facilities should be constructed and operated to replace the level of fishery restoration adequate to offset losses in the Pend Oreille estimated under 1.2.8 (Appendix B, p. 18).

1.8.8 The salmonid fisheries at Cascade Reservoir are dependent on annual plants of hatchery reared fish. These plants could be increased two to four times, greatly enhancing fishing quality within the carrying capacity of the reservoir. Budget constraints prevent the Department of Fish and Game from meeting these goals (Appendix B, p. 24).

1.8.9 Recommend appropriate mitigation measures for new hydropower projects proposed for the Payette River Basin (Appendix B, p. 24).

1.8.10 Continue stocking Dworshak Reservoir to provide fishing (Appendix B, p. 29).

1.8.11 Stock a race of river rainbow trout into the Clearwater River below the North Fork to establish a trout fishery to replace the smallmouth bass fishery which has been eliminated by cold water releases from Dworshak Reservoir (Appendix B, p. 29).

1.8.12 Maintain or increase the stocking of hatchery reared trout into suitable Snake River habitat where natural reproduction is not sufficient to provide an acceptable fishery (Appendix B, p. 34).

1.8.13 Protect and preserve the remaining areas of suitable free-flowing Snake River habitat for white sturgeon (Appendix B, p. 34).

1.8.14 Artificial propagation methods for white sturgeon are being successfully developed in California. Artificial propagation could restore sturgeon populations where natural reproduction has been limited by dams (Appendix B, p. 34).

1.8.15 Introduce suitable species of warm water game fish into vacant Snake River habitats which are unsuited for salmonids (Appendix B, p. 34).

1.8.16 Encourage development of commercial nongame fish fisheries by conducting and publishing research to inventory populations, development of fishing gear or techniques, and exploring market potentials (Appendix B, p. 34).

WASHINGTON

1.8.17 It is recommended that the authorized enlarged Bumping Reservoir project be constructed to provide major additional storage for mitigating the depredation of fish stream habitat, increased flexibility in Yakima River Basin water management, and develop additional hydrogeneration. Reservoir discharge should not be regulated for new and future hydro-generation at the expense of fishery needs (Appendix C, p. 32).

1.8.18 It is recommended that slough and embayment spawning and rearing areas in the Hanford Reach of the mid-Columbia River be protected by diking and other appropriate measures and that consideration for protection of such spawning and rearing areas be incorporated into mid-Columbia River hydroelectric planning and operations (Appendix C, p.11).

1.8.19 It is recommended that artificial warmwater fish habitat, such as reefs, gravel blankets, brush piles, and other appropriate measures be constructed in the vicinity of the Okanogan River in Wells Reservoir (Appendix C, p.12).

1.8.20 It is recommended that sloughs and/or embayments be constructed in Priest Rapids Reservoir to enhance smallmouth bass spawning and rearing habitat (Appendix C, p.13).

OREGON

1.8.21 We would like the Power Planning Council to direct the operating agencies to initiate studies to find ways of controlling nongame fish populations and implement (Appendix D, p. 2).

1.9 Protection of Natural Waters: Protect and maintain unaltered streams in natural conditions from any hydroelectric developments that cannot guarantee the project will not adversely affect game fish rearing habitat.

MONTANA

1.9.1 Critical habitat areas in North and Middle Fork Flathead River tributaries should be protected from any development that could not guarantee the project would not adversely affect gamefish rearing habitat (Appendix A, p. 23).

1.9.2 Compensation for loss of a significant migratory fishery in the Clark Fork drainage should include protection and maintenance of the Big Blackfoot River, Rock Creek and Fish Creek, and possible other Class I streams in a natural and unaltered condition (Appendix A, p. 84).

1.9.3 The Council should support the development of a process that protects aquatic and wildlife resources of significant value from future hydroelectric development. This would be a form of mitigation for past development needed to establish an essential balance between rivers and reservoirs. Highest priority would go to streams that could not be adequately mitigated (Appendix A, p. 104).

IDAHO

1.9.4 Retain the South Fork of the Payette River sub-basin in its present, free-flowing condition (Appendix B, p. 24).

1.9.5 Maintain the free-flowing river habitat and protect the watershed within the entire Salmon River Basin (Appendix B, p. 26).

1.9.6 Protect remaining free flowing streams in the Clearwater River Basin for trout fishing and for salmonid spawning (Appendix B, p. 29).

WASHINGTON

1.9.7 It is recommended that resident game fish population and habitat be protected by the prohibition of constructing new hydroelectric projects, or the restoration of decommissioned or abandoned ones on the following streams: Mid-Columbia River--Hanford Reach; Snake River--Asotin Project; Wenatchee River; Methow River; and Similkameen River (Appendix C, p29).

OBJECTIVE 2: MIGRATION

Provide conditions and/or facilities which ensure resident fish unimpeded access to spawning or rearing areas required for successful completion of their life cycle.

WASHINGTON

2.1 It is recommended that a barrier net be provided, operated, and maintained at the outlet into the main canal at Banks Lake. This will prevent the outmigration of kokanee, conserve their spawning population, and increase the number of fish available for sport harvest (Appendix C, p.18).

OBJECTIVE 3: OTHER PROJECT-RELATED MORTALITIES

Provide conditions and/or facilities at projects to reduce mortalities of resident fish to the greatest extent possible.

OBJECTIVE 4: FISHING OPPORTUNITY

Restore, maintain, and provide adequate information, access, facilities, and diversity of sport fishing opportunity to meet public demand.

OBJECTIVE 5: REPRESENTATION

Include formal resident fisheries representation in all matters of Columbia River Power System planning, management, and operation to provide equitable treatment for resident fisheries coequal to that of other interests.

MONTANA

5.1 The Council should include in the fish and wildlife program a method to insure that mitigation for fish and wildlife losses is a mandatory part of the process of planning, licensing, and development of projects (Appendix A, p. 105).

5.2 The Council should address the cumulative impacts of existing and future hydrodevelopment in its fish and wildlife program. Cumulative impacts should be addressed at the first level of appraisal before a project is proposed and include a firm commitment to an adequate mitigation plan (Appendix A, p. 105).

5.3 The Council should consider the impact of advanced energy withdrawal from storage reservoirs on reservoirs and downstream fish and wildlife resources to ensure an effective fish and wildlife program can be implemented (Appendix A, p. 104).

5.4 Potential site-specific and cumulative impacts of small-scale and micro-hydroelectric projects (installed capacity of five megawatts or less) should be evaluated to ensure that the resource assessment goals and objectives established by the Council in the energy plan are compatible with the intent of the fish and wildlife program (Appendix A, p. 105).

APPENDIX A

RECOMMENDATIONS AND SUPPORTING DOCUMENTS PERTAINING TO RESIDENT FISH IN MONTANA

A report to the Northwest
Power Planning Council
November 16, 1981

Prepared by: Pat Graham
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APPENDIX B

RECOMMENDATIONS AND SUPPORTING DOCUMENTS PERTAINING TO RESIDENT FISH IN IDAHO

A report to the Northwest
Power Planning Council
November 16, 1981

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Kootenai River Basin

Basin Description

Geography

The Kootenai River heads in British Columbia, flows southwest through the northwestern corner of Montana and then northwest through the northeastern corner of Idaho back into British Columbia. Approximately 66 miles of the Kootenai River flows through Idaho, from RM 105.63 to RM 171.60.

Major tributaries within Idaho include the Moyie River and Deep Creek.

The Kootenai River within Idaho is regulated by Libby Dam at RM 204.5 and affected by downstream dams which regulate the backwater of Kootenai Lake.

Hydrology

The Kootenai drains a total of 13,700 square miles, of which 1,960 square miles are in Idaho.

The average discharge at the Canadian border is 15,900 cfs or 11,520,000 acre feet/year.

Since 1972, annual and daily flows have been regulated by Libby Dam and Lake Koocanusa storage.

Recreation

Recreation is a major industry in the Idaho Panhandle. The Kootenai River and tributaries constitute the major fishery resource of Boundary County, Idaho. This resource attracts users from a large area including the Spokane, Washington urban area.

Resident Fish Resources

Rainbow trout are the most important trout species in the drainage. The Kootenai is the only drainage in the panhandle where rainbow are the native species. Westslope cutthroat, brook trout, Dolly Varden and kokanee provide substantial fisheries.

The only ling (Lota lota) population and the only consumptive white sturgeon fishery in Idaho occur in the Kootenai River.

Yellow perch, black crappie, bullhead catfish, largemouth bass and pumpkinseed sunfish provide locally popular fisheries in small lakes, tributaries and sloughs adjacent to the river.

An excellent, but underutilized population of mountain whitefish occurs in the river.

Libby Dam Project

Project Description

Libby Dam impounds Lake Koocanusa with nearly 5 million acre feet of active storage. Storage began in 1973 and powerhouse operations in 1975. Operation of the project reversed many habitat characteristics within Idaho. Flows are now highest during reservoir drafting in the fall and winter. The spring freshet has been eliminated. The river is relatively cooler in summer and warmer in winter than pre-dam conditions.

To date, fish and wildlife mitigation for the impacts of Libby Dam have been limited to the drainage within Montana.

History of Fish

The Kootenai River historically provided popular fisheries for ling, sturgeon and rainbow trout.

The operation of Libby Dam has greatly altered the flow patterns and temperature patterns of the river. Although historical data is lacking, the ling and sturgeon populations are much decreased. Reproduction of these species may be eliminated by the altered flow and temperature regimens. The rainbow trout population is far below the capacity of the habitat and the mountain whitefish population has expanded.

Impacts on Fish

Operations of Libby Dam appear to have reduced the habitat suitability for reproduction and growth of sturgeon and ling and favored the expansion of mountain whitefish. Whitefish flourish in the cooler temperatures provided by low level withdrawal from Lake Koocanusa. Whitefish are less restricted in spawning habitat and more adapted to the fluctuations in flow than are rainbow trout.

Management Goals and Objectives

The management goals on the Kootenai River include maintaining or restoring the ling and sturgeon fisheries and enhancing the rainbow trout fishery. A currently ongoing research project funded by the U.S. Army Corps of Engineers is expected to develop management recommendations to achieve these goals.

Recommendations to Protect, Mitigate and Enhance Fishery Resources

Enhance the rainbow trout population of the Kootenai River by planting fingerling trout of a suitable stock for the river habitat. (1.8.4)

Restore the sturgeon and ling population by implementing management programs recommended at the completion of the presently ongoing research project. (1.8.5)

Spokane River Basin

Basin Description

Geography

The Spokane River heads at the outlet of Coeur d'Alene Lake near the city of Coeur d'Alene, Idaho and flows through Idaho for approximately 12 miles to the Washington border.

Major tributaries are the Coeur d'Alene and St. Joe Rivers which enter Coeur d'Alene Lake.

The flow in the Spokane River and the level of Coeur d'Alene Lake is regulated by Post Falls Dam, a Washington Water Power hydroelectric project which is located on the Spokane River about 8 miles downstream from the lake outlet and 4 miles upstream from the Washington border.

Hydrology

The Spokane basin includes 3,840 square miles within Idaho. Annual discharge below Post Falls Dam averages 6,264 cfs (4,601,000 acre feet/year).

Post Falls Dam controls storage of 889,000 acre feet in Coeur d'Alene Lake between surface elevations of 2,120 and 2,140 feet.

Recreation

The Spokane River, Coeur d'Alene Lake and tributaries constitute a major recreational resource. Fishing and boating is extremely popular on these waters. Coeur d'Alene, Idaho and Spokane, Washington residents as well as tourists from around the world take advantage of the recreational opportunities.

Resident Fish Resources

Westslope cutthroat trout provide the major trout fishery in the rivers and lakes of the Spokane Basin. Rainbow trout also provide important fisheries, particularly in the Spokane River below Post Falls Dam. Coeur d'Alene Lake supports a major kokanee fishery with an annual harvest in the range of one-half million fish.

The Coeur d'Alene and St. Joe lateral lakes and bays of Coeur d'Alene Lake provide high quality and popular fisheries for largemouth bass, black crappie, Northern pike, yellow perch, bullhead catfish and sunfish.

Mountain whitefish and Dolly Varden trout also occur in the river system and lakes.

Post Falls Dam Project

Project Description

Post Falls Dam is an old Washington Water Power project built at the crest of a natural falls of the Spokane River. The dam regulates the upper 20 feet of Coeur d'Alene Lake as well as the "lateral lakes" in the lower valleys of the Coeur d'Alene and St. Joe Rivers.

History of Fish

Originally, Westslope cutthroat were the major trout fishery of Coeur d'Alene Lake. Kokanee salmon were introduced approximately 30 years ago and now constitute the major fishery. Fishing pressure and tributary stream degradation has caused the cutthroat population to decline. Mixed populations of warmwater fish flourish in the bays of Coeur d'Alene Lake and in adjacent sloughs and lateral lakes.

The state records for largemouth bass (10 lbs. 15 oz.) and Northern pike (27 lbs. 4 oz.) were taken in this area. Populations of Westslope cutthroat trout have been restored in the upper tributaries through spawning stream closures and restrictive fishing regulations.

Impacts on Fish

The fish populations of the Spokane Basin have adapted to the operation of Post Falls Dam. The dam is operated to maintain a downstream fish conservation flow at all times and to minimize impacts of lake drawdown on kokanee.

Management Goals and Objectives

Coeur d'Alene Lake will be managed as a kokanee fishery. Adfluvial cutthroat will be protected and enhanced where possible. An additional pelagic predator introduction is planned to provide trophy fishing and to control the kokanee population which is becoming overabundant.

Recommendations to Protect, Mitigate and Enhance Fishery Resources

Introduce chinook salmon and/or Kamloops rainbow trout as a pelagic predator in Lake Coeur d'Alene to provide a trophy fishery and to control overabundant kokanee. (1.8.6)

Maintain operation of Post Falls Dam to minimize impacts on fishery resources. (1,2.7)

Pend Oreille Basin

Basin Description

Geography

The Pend Oreille River heads at the outlet of Lake Pend Oreille. The major drainage of the basin is the Clark Fork system which is the primary tributary to Lake Pend Oreille.

Pend Oreille is the largest lake in Idaho at about 94,720 acres maximum surface area. It is located east and south of the town of Sandpoint in the northern part of the state within 50 miles of the Canadian border. The lake is approximately 30 miles long and two to seven miles wide. Pend Oreille is one of the deepest lakes in the United States with a maximum recorded depth of 1,152 feet and a mean depth of approximately 540 feet.

The only large tributary within Idaho is the Priest River. Within Montana, the Clark Fork basin includes the Flathead, Bitterroot and Blackfoot systems.

Hydrology

The Pend Oreille basin drains 24,200 square miles of which 2,127 square miles lies within Idaho.

The average discharge at the Idaho-Washington border is 25,930 cfs (18,790,000 acre feet/year), approximately 10% of the Columbia River flow at the Dalles.

The flow is regulated by Albani Falls Dam on the outlet of Lake Pend Oreille as well as instream storage at Flathead Lake, Hungry Horse Reservoir and several smaller storage projects including Priest Lake outlet dam within Idaho.

Recreation

Recreation is a major industry in the Idaho Panhandle and the Pend Oreille Basin is the major recreational resource. Boating and fishing support dozens of resorts, marinas and sporting goods stores. At the present time, with lumber products and

mining industries in a depressed state, recreation is the most stable and viable of the local industries.

Kamloops, as the unique Gerrard rainbow are called locally, and kokanee, along with local interest in cutthroat trout and Dolly Varden have attracted a major tourist industry associated with Pend Oreille Lake over the years. The unique fishery for trophy species and the high-yield kokanee fishery in particular was promoted by Sandpoint businessmen and produced recreation dollars to the north Idaho economy on a large scale. Even with declines in kokanee harvest from around one-million fish caught from the early '50's to the late '60's to present levels of under 200,000 fish, the economic values generated by the fishery are considerable.

In 1979, a few of the many area merchants who derive income from the fishery reported $245,450 in boat slip revenue, $1,217,000 for boat sales, $150,000 for tackle and $180,000 for automobile sales were directly attributable to the fishery from their business alone. Additional economic impacts include major unquantified retail sales for food, lodging and entertainment by recreationists drawn to the lake fishery. The cash value of the harvest from Pend Oreille Lake alone is $151,107 at a modest price of $2.00 per pound. Estimating a day of fishing on Pend Oreille to be worth a conservative $55.00 places the value of the trout and kokanee fishery at more than $3 million at present harvest levels. The potential exists to more than double this figure with a fishery restoration program.

Resident Fish Resources

Westslope cutthroat trout, bull trout (Dolly Varden) and mountain whitefish are the game fish native to the system. Kokanee salmon entered the lake in the early 1930's from Flathead Lake and rapidly replaced the native whitefish as the predominant pelagic species. In less than a decade the increasing kokanee population caused local concern with the decreasing size of fish. In 1941 and 1942, area sportsmen introduced the Gerrard strain of rainbow trout unique to Kootenay Lake,

B.C. to control kokanee numbers. By 1947 a big rainbow from Pend Oreille established the 37-pound world record for inland waters. A 32-pound Dolly Varden was caught in 1949, also a world record.

Cabinet Gorge Project

Project Description

Cabinet Gorge Dam is a 205-foot high structure located on the Clark Fork River 11 miles upstream from Lake Pend Oreille. The extensive Clark Fork system lies almost entirely in Montana, entering Idaho just above the dam site. Inflow from the Clark Fork averages 22,380 cfs on an annual basis, most of the runoff for Pend Oreille Lake. The contribution to the Columbia system at this point is also considerable, 10% of the annual runoff at the Dalles, Oregon. Over 150 tributaries form the large river which enters Pend Oreille as the Idaho portion of the Clark Fork. These include major river systems such as the Flathead, Bitterroot and Blackfoot which enter the Clark Fork 100-200 miles upstream in Montana. The drainage area exceeds 22,000 mi^2 and produces flows ranging from 762-153,000 cfs.

History of Fish

At one time this entire drainage produced fish which entered Pend Oreille Lake. Most of the Clark Fork system is rated by Montana as Class I or II streams (high value fishery resources). Historically, these drainages produced highly valued cutthroat trout, Dolly Varden and mountain whitefish. Several million kokanee were also known to enter the Clark Fork for spawning prior to dam construction. Presumably Gerrard rainbow would have also utilized the Clark Fork system had upstream passage been maintained. Presently it appears that the contribution of game fish from the system is limited to small numbers by the presence of several dams. A small population of brown trout has resulted in the Pend Oreille system as a result of emigration from Montana.

Historically the lake also supported a good fishery for cutthroat trout. These

fish rear 1-3 years in tributary streams before the juvenile fish enter the lake system. With loss of virtually all of the Clark Fork system, impacts on the numbers of fish available to support the lake fishery have been particularly severe. Long term declines in the harvest of native cutthroat from Pend Oreille Lake are also related to the effects of fishing pressure on this vulnerable species. Hydroelectric development on the Clark Fork has, however, reduced the capacity of the lake population to support a fishery over the last three decades.

Milltown Dam, built in 1906, was the first impoundment on the main stem of the Clark Fork River. Upstream migrations of fish were totally blocked by this structure. Dolly Varden and cutthroat trout, many likely from Pend Oreille Lake, 225 miles downstream, were impacted. No attempt has been made to mitigate for the blockage of migratory runs of fish in the Clark Fork River. Dams contructed downstream from Milltown are now blocking runs of migratory fish which originate in Lake Pend Oreille.

Once Cabinet Gorge Dam was closed, runs of migratory fish were restricted to the lower 11 miles of the Clark Fork. Presently, most of this area is unsuitable for spawning as flow fluctuations do not provide continuous coverage of spawning gravels of proper sizes. As is also normal below dam sites, gravel recruitment from upriver areas has been eliminated.

Albeni Falls Project

Project Description

Albeni Falls Dam is located on the Pend Oreille River about 20 miles donwstream of Sandpoint. The project was authorized by Congress in 1950 to regulate Pend Oreille Lake for flood control, navigation fish and wildlife conservation, power generation and recreation. Construction was started in 1951, storage was available in the fall of 1952, and on-site power generation began in 1955. The dam is operated by the U. S. Army Corps of Engineers, Seattle District.

Normally the lake is fluctuated a maximum of 13 feet between elevations

2,049 and 2,062. The more than one-million acre feet of storage in Pend Oreille Lake can produce some 1.4 billion kilowatt hours of energy at downstream power plants. In order to realize downstream benefits the lake must be drawn after September 1, in fact, the best operation for power benefits would involve a February drawdown.

Considerable effort has been expended to utilize the storage from the many reservoirs in the Columbia River system so that drawdown is not scheduled after December 1 whenever possible. The purpose of the early drawdown is to minimize impacts of dewatering gravels used by kokanee for lakeshore spawning. Prior to impoundment by Albeni Falls Dam, lake levels remained relatively constant or increased from the onset of kokanee spawning in October through the late spring period when the fry emerge from the gravels. Since impoundment, drawdown has occurred because of power requirements after kokanee eggs were in the gravel resulting in the loss of eggs and sac-fry.

As noted in Flathead Lake the historical use of shallow shoreline areas for kokanee reproduction has gradually been eliminated possibly as a result of water level fluctuation since impoundment. On Pend Oreille where alternate large tributary systems suitable for kokanee spawning do not exist, the lake population began to decline steadily in the late '60's. Whether the early fluctuations in the fishery were related to drawdown is not clear.

By 1974 another factor resulted in a rapid deterioration of the kokanee fishery. Mysis relicta, the opossum shrimp, introduced from Kootenay Lake to produce larger kokanee became established in Pend Oreille and caused a rapid and continuing decline in kokanee numbers. This impact has masked many of the problems associated with both hydro projects.

Impacts on Fish

Cabinet Gorge Dam blocked spawning runs of the three major trout species as well as kokanee, severely restricting the ability of game fish to reproduce and maintain the excellent quality sport fisheries of Lake Pend Oreille.

Albeni Falls Dam has created unnatural fluctuations in the levels of Lake Pend Oreille, impacting the shoreline spawning portion of the kokanee population.

At the present time, the fisheries of Lake Pend Oreille are far below historical levels.

The outlet dam at Priest Lake is operated to maintain lake levels for summer recreation. Fall and winter drawdown occurs to supply water for hydroelectric generation at Albeni Falls and downstream projects. The drawdown severely impacts shoreline spawning kokanee.

Mitigation of Project Impacts

On December 4, 1950 the Department of Interior stressed the value of the fishery and recommended against the construction of Cabinet Gorge Dam:

"Lake Pend Oreille, which is approximately 9 miles below the project site, supports one of the most extensive fisheries in western United States. Record catches of several species have spread its fame throughout the Nation. Millions of dollars have been invested in recreational facilities around the lake. Angling pressure for Kamloops, Dolly Varden, and cutthroat trouts and land-locked blueback salmon (kokanee), is extremely heavy. The commercial fishery, alone, is reported to take between 50 to 100 thousand pounds of kokanee annually.

"Maintenance of this important lake fishery is dependent mainly upon the spawning runs of trouts and kokanee in the Clark Fork River. The proposed project, which would form an impassable barrier approximately nine miles above Lake Pend Oreille, would eliminate the greater portion of spawning areas presently available to migratory fish above the damsite, and due to proposed peaking power operations with fluctuations in flow from zero to more than 230,000 second-feet, may completely eliminate the productivity of the excellent spawning gravels below the dam.

"In addition to these harmful effects, the project would replace approximately twenty miles of good stream habitat with an impoundment of doubtful value. The

fluctuating reservoir probably will not supply fishing of high quality nor receive heavy use.

"In view of the foregoing, and the fact that the proposed operation and height of dam preclude the feasibility of an efficient fish ladder, the Fish and Wildlife Service recommends that a license for this project not be granted. Should a license be issued, however, it is requested that the following provisions be made a part thereof:"

1. "A minimum flow of 3,000 second-feet shall be provided at all times below the powerhouse.

2. "Changes in rates of release shall not be permitted to increase to double or decrease to half that of any prevailing flow within one hour.

3. "Free public access shall be permitted to all portions of the project area except for those areas reserved for safety and efficient operation.

4. "The licensee shall construct a fish hatchery, together with trapping facilities, of sufficient size to mitigate any losses occurring under project conditions not compensated by modification of operation in accordance with recommendations 1 and 2. The cost of land acquisition, water rights and facilities, construction, annual maintenance, and operation, shall be borne by the licensee. The selection of a site, and the design and size of the hatchery shall be determined by a cooperative agreement between the Idaho Department of Fish and Game, the Fish and Wildlife Service, and the Washington Water Power Company, this agreement to be consummated prior to initiation of construction."

The above letter, as well as information on following pages, was exerpted from the supplementary Follow-up Report for Cabinet Gorge Project conducted by the United States Department of the Interior, Fish and Wildlife Service, Portland, Oregon, May, 1966. This information describes mitigation efforts entered in by members of the Lake Pend Oreille Evaluation Committee formed to recommend measures

for the Cabinet Gorge and Albeni Falls projects. As can be seen by the Fish and Wildlife Service analysis the effectiveness of these measures was not good even for the mitigation era of the 1950's and 1960's:

Effects on Fish

General

The project has reduced the numbers of Dolly Varden and cutthroat trout in Pend Oreille Lake and Clark Fork River downstream from Cabinet Gorge Dam. Kokanee and Kamloops have remained relatively stable in Pend Oreille Lake.

As noted previously, kokanee populations have declined dramatically though the role of Albeni Falls and Cabinet Gorge Dams in this decline is unclear. The following information gives the indication that additional mitigation measures were not recognized as necessary due to conditions at the time.

A creel census study was initiated in 1951 in an attempt to assess the effect the project would have on the quality of fishing in Pend Oreille Lake. This eight-year study, financed by the Washington Water Power Company and conducted jointly by the Idaho Fish and Game Department and the company, showed that Pend Oreille Lake supports one of the most valuable sport fisheries in the United States. During the study period, the annual catch from Pend Oreille Lake ranged from approximately 525,000 to more than one-million fish.

In December 1955, a technical committee comprised of representatives of several agencies was established to review annual results of the study. In February 1957, the committee recommended that while the creel census showed no significant change in the quality of kokanee fishing in Pend Oreille Lake, steps should be taken to offset possible cumulative losses that might not be reflected in the creel census data. This was deemed necessary because some known losses to the kokanee resource did occur even though the general quality of fishing for this species remained high. For example, some kokanee eggs on the four-mile reach of the Clark Fork River between

Pend Oreille Lake and Whitehorse Rapids are at certain times subject to desiccation and freezing because of fluctuating water levels. As a result of measurable Dolly Varden and cutthroat trout declines and to insure against possible future kokanee declines, the following mitigative measures and facilities were recommended: (1) stream improvements at Granite Creek, Sullivan Springs, and Spring Creek; (2) an artificial spawning channel on Spring Creek at Clark Fork hatchery; and (3) an incubation and hatching battery of sufficient capacity to handle one-million kokanee eggs.

These measures and facilities were completed. The company paid its share of the construction costs and all of the costs of operation and maintenance of the facilities for five years. The spawning channel and about 4,400 feet of improved streambed on Spring Creek have received considerable use by Kamloops trout in the spring, and by kokanee and a few Dolly Varden in the fall. The improved spawning habitat on Granite Creek and Sullivan Springs, totalling 2.75 miles, has been used principally by kokanee and Dolly Varden. In addition, about 2,000 feet of Gold Creek have been improved and are used mainly by Dolly Varden.

Kokanee continue to be the most plentiful fish taken in Pend Oreille Lake, and the annual harvest has not changed significantly since Cabinet Gorge Dam was constructed. In addition to the sport fishery, there is also a commercial fishery for this fish. Approximately one-million kokanee were taken in the combined commercial and sport fisheries during 1963. While numerically the kokanee were shown to comprise over 90% of the harvest, the trout species are very important in that over 20% of the total fishery effort on Pend Oreille Lake is devoted to the taking of the Kamloops, Dolly Varden and cutthroat trout. The harvest of Kamloops trout increased annually during the study period but has stabilized somewhat in recent years, while the take of cutthroat trout and Dolly Varden has decreased.

The Dolly Varden fishery has declined the most. The annual take for the 1959-63

period was only about one-half that for the 1954-58 period. Blockage of the Clark Fork River and its tributaries by Cabinet Gorge Dam is believed to be the major cause of this decline. Since 1960, as a mitigation measure, two spawning areas were developed in the Clark Fork River below the dam. Both developments were financed by the company. Dolly Varden and kokanee are now using these spawning areas.

In 1962, the company and the Idaho Fish and Game Department agreed upon a final plan for mitigation of project-caused fish losses in Pend Oreille Lake. The plan provided for the company to obtain up to 200,000 Dolly Varden eggs annually for four years. The eggs would be seeded in the developed spawning areas below the dam to supplement natural spawn. The plan also called for the company to evaluate the efficiency of the spawning areas. The company, in cooperation with the University of Idaho, is sponsoring a graduate study to determine the effectiveness of these areas.

Difficulties have been experienced by both the company and the State in obtaining Dolly Varden eggs in the quantities needed. Consideration is currently being given to the possibility of developing additional spawning areas in lieu of providing these eggs.

In 1964, the Idaho Fish and Game Department closed all tributaries of Pend Oreille Lake to Dolly Varden fishing in a further effort to conserve the Dolly Varden fishery in the lake. These tributaries have remained closed since that date.

Effectiveness of Recommendations Listed

1. The recommendation was not followed. Studies conducted by the Idaho Fish and Game Department and the Washington Water Power Company show that due to the operation of Cabinet Gorge Dam and Albeni Falls Dam (a Corps of Engineers project which controls levels of Pend Oreille Lake), most of the river bottom is under water at all times.

A three-mile-long tailrace pool occurs immediately downstream from Cabinet

Gorge Dam. This pool varies in depth from about 70 feet near the dam to approximately 18 feet just upstream from White Horse Rapids. Another pool, having a maximum depth of approximately 78 feet, lies downstream from White Horse Rapids and is about 1½ miles long, terminating at Foster Rapids. These pool areas, coupled with springs and bank storage, have provided enough water to maintain a large portion of the stream habitat, even during complete shutdown at the dam. Under normal operating conditions, shutdown lasts approximately 4 to 6 hours. The maximum shutdown period has been about 12 hours.

2. The recommendation was not followed. At times project operations necessitate rapid changes in the rate of release.

3. The recommendation was followed. Free public access to the reservoir is provided. The company is currently working with the U. S. Forest Service and the Montana Department of Fish and Game in the design of an overall recreation plan. Two campgrounds have already been completed. One is located at the mouth of Bull River; the other at Big Eddy near the town of Heron, Montana. Both have boat launching facilities.

4. The recommendation was not followed. A fish hatchery was not constructed, but an incubation and hatching battery, two artificial spawning areas, and an artificial spawning channel were constructed, and stream improvement measures were undertaken, in order to mitigate project-caused losses to the fishery resource of Pend Oreille Lake.

In spite of the long history of studies, negotiations, agreements, mitigation efforts and other impacts to the Pend Oreille system, hydroelectric impacts on the fishery have not been adequately addressed. Continuing problems are summarized below:

1. The role of the two projects, Cabinet Gorge and Albeni Falls, in the decline of kokanee, cutthroat and Dolly Varden was never quantified.

2. Spawning channels constructed to offset fishery losses were never adequate to replace the hundreds of miles of high quality spawning and rearing habitat lost in the Clark Fork drainage.

3. The power companies were subsequently absolved of further responsibility by an agreement with the Idaho Department of Fish and Game.

Recommendations:

A) A study should be conducted to review all existing information to determine the relative role of the two hydroelectric facilities on the Pend Oreille system in declines of major sport species. (1.2.8)

B) As recommended in 1950, hatchery facilities should be constructed and operated to replace the level of fishery restoration adequate to offset losses estimated under (A-1.2.8) above (1.8.7).

Boise River Basin

Basin Description

Geography

The Boise River drainage flows in a westerly direction from the western and southern portions of the Sawtooth Mountain range, onto the Snake River plain and enters the Snake River at RM 391.3 near Parma, Idaho.

Major tributaries are Mores Creek and the North, Middle and South Forks.

There are four large irrigation storage reservoirs in the basin, one of which, Anderson Ranch Reservoir, is used for hydroelectric generation.

Hydrology

The Boise drains 3,470 square miles and has an average discharge to the Snaker River of 1,650 cfs (1,195,000 acre ft/year). Irrigation diversions from the river system irrigate some 300,000 acres of farm land.

Four large storage reservoirs are located within the Basin: Lake Lowell (10,000 surface acres, 200,000 acre feet storage), Lucky Peak Reservoir (2,800 surface acres, 307,040 acre feet storage), Arrowrock Reservoir (4,000 surface acres, 290,000 acre feet storage) and Anderson Ranch Reservoir (4,500 surface acres, 425,000 acre feet storage). In addition there are numerous smaller irrigation impoundments.

Resident Fish Resources

Rainbow trout are the dominant native salmonid species of the Boise Basin and presently provide the most important salmonid fishery. Brook, brown, cutthroat and Dolly Varden provide important fisheries in portions of the basin. Kokanee support fisheries in the large reservoirs. Smallmouth bass, largemouth bass, bluegill and pumpkinseed sunfish, black crappie, yellow perch, bullhead and channel catfish are present and dominate the lower elevation waters. Large populations

of nongame fish occur in the reservoirs and low elevation streams.

Anderson Ranch Dam

Project Description

Anderson Ranch Dam is located at RM 43.5 on the South Fork Boise River. The reservoir is operated for irrigation storage, flood control and hydroelectric generation. As the highest reservoir on the drainage, and the only dam with generating capacity, Anderson Ranch is operated to fill first and drain last.

History of Fish

Kokanee salmon provide the major reservoir fishery. Rainbow trout provide the major river fishery above and below the reservoir. Since 1972 smallmouth bass have become established in the reservoir and support a popular fishery along the shoreline.

Impacts on Fish

Anderson Ranch Dam created a large reservoir habitat suited for kokanee. After initial introductions of the species by IF&G between 1965 and 1972, a naturally reproducing population became established which presently supports 100,000+ hours of fishing and produces an annual catch of 50,000 to 100,000 fish. Water released through the turbines is 42°F ±2° year around. Therefore, the river is relatively warmer in winter and cooler in summer than natural conditions. The stabilized water temperature has favored development of an excellent rainbow trout and mountain whitefish fishery.

Since 1979, minimum flows and regulated peaks have been voluntarily provided by the USBR who operates the dam. These flows will be required under the operating schedule when Anderson Ranch Powerplant is rebuilt in the next few years.

Management Goals and Objectives

Maintain the present management for kokanee and smallmouth bass in the reservoir, quality rainbow trout fishing and whitefish in the rivers.

Recommendations to Protect, Mitigate and Enhance Fishery Resources

Guarantee instream flow minimums for overwintering and spawning trout in the South Fork below Anderson Ranch Dam. (1.3.2)

Other Hydroelectric Projects

The Boise River system is harnessed and controlled by a series of storage dams, diversion dams and canals. A number of hydroelectric projects have been suggested at outlets, drains and drop structures. Each new development will have some impacts on fishery resources and will require one or more of the following measures to mitigate or minimize impacts (1.2.9):

1. Within the constraints of existing diversion and storage rights, instream flows sufficient to maintain aquatic resources should be provided.

2. Turbine intakes should be screened or game fish lost to turbine mortalities should be replaced.

3. Introductions of suitable species of game fish should be made as necessary to maintain sport fisheries in all waters affected by hydropower projects.

4. Habitat degraded by hydroelectric development should be restored or replaced.

Basin Description

Geography

The Payette River is a major drainage of west-central Idaho, joining the Snake River at RM 365.6 near the town of Payette.

Major tributaries of the Payette River are the North, Middle and South Forks and the Deadwood River. The basin lies entirely within Idaho.

Dams on the Payette drainage include Cascade on the North Fork, Deadwood on the Deadwood River and Black Canyon on the main Payette near Emmett. These three dams are primarily irrigation storage and diversion dams, however, hydroelectric generating capacity at Cascade is presently being increased by a new powerhouse being built by Idaho Power Company. Deadwood Dam includes a small turbine to generate power for adjacent federal facilities increased generating capacity is possible. Black Canyon Dam includes hydropower facilities. In addition, Idaho Power Company is seeking federal permits to construct new hydroelectric facilities on the North Fork downstream from Cascade Reservoir and has proposed 3 new dams on the South Fork.

Hydrology

The Payette River drains 3,240 square miles and discharges an average of 3,080 cfs (2,231,000 acre feet/year). Besides Deadwood and Cascade Reservoirs there are numerous small irrigation impoundments and control structures and natural lakes within the basin. Diversions from the river system irrigate approximately 200,000 acres.

Recreation

The Payette Basin receives heavy recreational use from the nearby

Boise/Treasure Valley area which contains approximately one-third of the population of Idaho. Cascade Reservoir is the single most heavily used fishery in the state according to a 1978 statewide survey. Hunting, fishing and boating on the waters of the basin are a major recreational and economic resource.

Resident Fish Resources

The Payette Lakes at the headwaters of the North Fork contain one of the few native kokanee populations in Idaho. Rainbow trout produce the major salmonid fisheries in both lakes and streams. Lake, brook, borwn and cutthroat trout provide a popular and heavily used fishery. A mixed warm water fishery is present in the lower Payette. Yellow perch in Cascade Reservoir and black crappie in Paddock Valley are two of the most popular warm water fisheries in the state.

Cascade Project

Project Description

Cascade Reservoir was constructed as a flood control and irrigation storage reservoir. Completed in 1949, the dam created a 30,000 surface acre reservoir storing 703,200 acre feet of water. Water releases are regulated for summer irrigation demand and hydropower generation at Black Canyon power plant.

A small powerhouse is operated at Cascade Dam. This powerhouse is presently being replaced by a larger unit by Idaho Power Company. Hydrogeneration will be dependent on existing release schedules.

History of Fish

During the early years after construction, Cascade Reservoir was an excellent rainbow trout fishery. Northern squawfish populations dominated the population from the mid-50's until the early 70's, when successful chemical treatments reduced squawfish populations and allowed an established yellow perch population to expand into the available habitat.

Presently Cascade provides excellent fishing for 9 to 14 inch yellow perch. Approximately 80,000 catchable size rainbow trout and 1.5 million fingerling rainbow, kokanee and coho are planted annually and create an excellent salmonid fishery. The stocking rate of 50 fingerling salmonids per acre is far less than carrying capacity for the productive water.

Impacts on Fish

Cascade Dam eliminated some fair river and stream habitat and created one of the most productive reservoir fisheries in Idaho. Nongame fish populations are a problem, but appear to be kept in check by game species.

Management Goals and Objectives

Continue present management of Cascade Reservoir as a hatchery supported salmonid fishery supplemented by natural reproduction of yellow perch.

Recommendations to Protect, Mitigate and Enhance Fishery Resources

The salmonid fisheries at Cascade are dependent on annual plants of hatchery reared fish. These plants could be increased two to four times, greatly enhancing fishing quality within the carrying capacity of the reservoir. Budget constraints prevent the Department of Fish and Game from meeting these goals. (1.8.8).

Recommend appropriate mitigation measures for new hydropower projects proposed for the basin. (1.8.9).

Retain the South Fork sub-basin in its present, free-flowing condition. (1.9.4)

Salmon River Basin

Basic Description

Geography

The Salmon River drains the central Idaho Mountains, including the River of No Return Wilderness area. The drainage runs generally north and west to join the Snake River at RM 188.2.

The Salmon River and major tributaries including the South, Middle, North and Yankee Forks, Little Salmon, Lemhi and Pahsimeroi Rivers constitute the largest undammed river system in the entire Columbia drainage.

Except for numerous small hydroprojects which provide electricity for isolated ranches and resorts, there is no hydropower development of the drainage.

Hydrology

The Salmon drains 14,100 square miles and produces an average discharge of 11,250 cfs (8,151,000 acre feet/year). It is second in size only to the Clearwater among Snake River tributaries.

There are a number of small irrigation impoundments and irrigation diversions from natural stream flow but the drainage is essentially free flowing.

Recreation

Fishing and whitewater boating on the Salmon and tributaries are a major recreational resource and provide an important and stable component of the economy throughout the Salmon Basin.

Resident Fish Resources

Rainbow, cutthroat, Dolly Varden and brook trout support popular fisheries of excellent quality in the Salmon River and tributary drainages. There are over

3,000 miles of free flowing streams and 700 alpine lakes in the drainage. Mountain whitefish, grayling, golden trout and kokanee also occur in the drainage. White sturgeon occupy deep pool areas in the Main Salmon River.

The free flowing rivers, particularly in the wilderness areas, provide quality wild trout fishing of national reputation.

Hydropower Projects

There are no significant hydropower projects in the Salmon Basin, although some have operated in the past and others have been proposed. Wild and Scenic River designations preclude development on the major streams.

Management Goals and Objectives

Maintain quality wild trout fisheries.

Recommendations to Protect, Mitigate and Enhance Fishery Resources

Maintain the free flowing river habitat and protect the watershed within the entire Salmon Basin. (1.9.5).

Clearwater River Basin

Basin Description

Geography

The Clearwater River runs from east to west across north-central Idaho and enters the Snake River on the Washington border at RM 139.3. The Clearwater Basin lies entirely within Idaho.

Major tributaries of the Clearwater River are the North Fork Clearwater, South Fork Clearwater, Lochsa and Selway Rivers.

Only one hydropower project is presently operating on the Clearwater drainage. Dworshak Dam is located at approximately RM 2 on the North Fork.

Hydrology

The Clearwater drains approximately 9,570 square miles and has an average discharge of 15,480 cfs (11,220,000 acre feet/year).

Dworshak Reservoir controls flood waters of the North Fork and provides power generation. Dworshak is one of the major hydropower storage reservoirs in the Columbia system with approximately two million acre feet of active storage out of the total 3,459,000 acre feet maximum storage.

Recreation

Fishing is a major recreational activity within the Clearwater drainage. Kelly Creek, Lochsa and Selway Rivers are known for native wild Weststlop cutthroat trout fisheries. Dworshak Reservoir at 17,000 surface acres makes up approximately one-third of the total water area in the drainage and is the only large body of standing water.

As such, it receives a major portion of boating and fishing recreation expended within the drainage.

Resident Fish Resources

Westslope cutthroat trout are the major species in the streams of the Clearwater drainage. Rainbow, brook and Dolly Varden trout provide substantial fisheries in the 430 alpine lakes and 3,200 miles of streams in the drainage. Warmwater species provide locally popular fisheries in several small low-elevation impoundments and in Dworshak Reservoir.

Dworshak Dam Project

Project Description

Dworshak is a 700 foot high dam which impounds 3.5 million acre feet of water in a 17,000 acre reservoir which backs water approximately 50 miles up the North Fork. Storage began on September 27, 1971.

History of Fish

The North Fork traditionally supported native cutthroat and rainbow/steelhead trout fisheries. Mountain whitefish and Dolly Varden also provide good fishing.

Impacts on Fish

Dworshak Reservoir flooded approximately 100 miles of the North Fork, Little North Fork and tributaries eliminating stream habitat, but creating a large lake habitat. Kokanee salmon, rainbow trout and smallmouth bass were introduced to enhance the reservoir fishery. Costs of fish stocking are borne by the U.S. Army Corps of Engineers as part of project operations.

Releases from the reservoir have cooled the lower 40 miles of the Clearwater River, eliminating a popular smallmouth bass fishery and creating habitat suitable for rainbow trout and whitefish.

Anadromous fish have been eliminated from the North Fork drainage, which has contributed to expansion of the resident cutthroat population.

Management Goals and Objectives

Continue to manage Dworshak Reservoir for kokanee and rainbow trout.

Manage upper tributaries of the North Fork and undammed portions of the drainage for native Westslope cutthroat and rainbow trout.

Recommendations to Protect, Mitigate and Enhance Fishery Resources

Protect remaining free flowing streams for trout fishing and for salmonid spawning. (1.9.6)

Continue stocking Dworshak Reservoir to provide fishing. (1.8.10).

Stock a race of river rainbow trout into the Clearwater River below the North Fork to establish a trout fishery to replace the smallmouth bass fishery which has been eliminated by cold water releases from Dworshak Reservoir. (1.8.11)

Snake River Drainage

Basic Description

Geography

The Snake River enters Idaho at RM 918.0 on the Wyoming border near Alpine, Wyoming. The Snake flows in a broad arc across southern Idaho, then turns north, forming the western border of the state for approximately 250 miles. A total of 778.7 miles of the Snake River is within or bounds Idaho.

Throughout its length within Idaho the main stem of the Snake River is controlled by 12 hydropower and/or irrigation dams. Numerous pump diversions are located across the Snake River plain.

Major tributaries to the Snake include the Clearwater, Salmon, Weiser, Payette, Boise, Malad (Wood), Portneuf, Blackfoot and Henrys Fork drainages. All except the Salmon are controlled and regulated by hydropower and/or irrigation dams.

Hydrology

The Snake River at the point it leaves Idaho, drains an area of 103,200 square miles and discharges an average of 51,260 cfs (37,140,000 acre feet/year). Approximately 80 percent of the state drains into the Snake River.

Elevation within the drainage varies from 12,602 feet msl at Mt Borah to 700 feet msl at Lewiston. Precipitation ranges from less than 10 inches per year in the southern Idaho deserts to temperates rain forests in the Clearwater drainage.

Recreation

Recreation is generally accorded third place in Idaho industries behind agriculture and forest products. At the present time the forest products industry is depressed and recreation is probably running a close second to agriculture in the Idaho economy.

Recreation is a stable segment of the economy, but is dependent upon the quality of recreational opportunity available. Some 500,000 fishermen utilize Idaho fisheries each year. Approximately one-third of Idaho fishing license sales are nonresident season or short-term licenses. Tourism, of which fishing is a major component, brings substantial amounts of new money into the Idaho economy. The population of Idaho is approximately 1 million, and about 300,000 resident licenses and permits are issued. Unlicensed juveniles and other anglers exempt from license requirements make up a substantial portion of the fishing population. A recent survey indicated that 85 percent of Idaho households have at least one member who fishes.

Resident Fish Resources

The fisheries of the Snake Basin are as diverse as the terrain and habitat. From Lewiston upstream to Twin Falls warm water species are most common. Smallmouth bass, channel and flathead catfish occupy the free-flowing river sections. Largemouth bass, black crappie, bluegill, yellow perch and bullhead catfish as well as the three previously mentioned species are present in impoundments and adjacent sloughs and backwaters. Rainbow trout are the most common salmonid and provide major fisheries in dam tailraces and some impoundments. White sturgeon also occupy most of the free-flowing areas and dam tailraces. Kokanee and landlocked coho salmon provide fisheries in some areas. Upstream from Twin Falls and above 3,000 feet elevation, salmonid fisheries become dominant. Snake River cutthroat are the native trout of the basin upstream from Twin Falls, however, rainbow trout are presently the most common species. Brown trout provide some important fisheries as do kokanee, landlocked coho salmon and lake trout. Mountain whitefish occur throughout the basin.

Snake River Hydropower Projects

Project Descriptions

Hydroelectric power is generated at Hells Canyon, Oxbow, Brownlee, Swan Falls, C. J. Strike, Bliss, Lower Salmon Falls, Upper Salmon Falls, Milner, Minidoka, American Falls and Palisades Dams on the Snake River. In addition, there are hydropower projects built at natural falls at Twin, Shoshone and Idaho Falls. Approximately 250 miles of the Snake River is impounded and covered by dam backwaters.

History of Fish

The primary native game fish below Twin Falls were white sturgeon, mountain whitefish and rainbow trout. Above Twin Falls cutthroat and whitefish were present. Impoundment and diversion has eliminated much of the sturgeon habitat and reduced the suitability of trout habitat. Excellent warm water populations have become established in the impoundments and much of the flowing water.

Impacts on Fish

Impoundment and diversion has drastically altered the habitat of the Snake River. None of the dams have upstream fish passage facilities, isolating populations in the intervening river sections. Backwaters of reservoirs tend to increase water temperatures, while low level outlets in some dams cool the water. Some dams discharge water low in dissolved oxygen from bottom outlets, others create gas supersaturation from high spillways. Peaking operations interfere with spawning of warm water and salmonid species. Salmonid fisheries have become restricted to dam tailraces, spring fed areas and deeper reservoirs. Warm water species have become dominant in most reservoirs and river sections. Nongame fish have been favored by the general warming trend and impoundments and have greatly increased in abundance. White sturgeon populations are restricted to a few free-flowing canyon areas which still meet their habitat requirements.

Resident fish mitigation has been limited to sporadic planting of fingerlings and catchable size rainbow trout and cooperation in initial introductions of warm water species into new impoundments. No attempt has been made to mitigate for white sturgeon. In most cases the burden of establishing and maintaining resident fisheries has been assumed by the Idaho Department of Fish and Game and fish stocking and management has been funded by fishing license fees.

Idaho Department of Fish and Game operates 12 trout hatcheries, producing 800,000 to 1.2 million pounds of catchable size trout and several million fry or fingerling rainbow, brook, brown, lake and cutthroat trout, kokanee, landlocked coho and chinook salmon, and miscellaneous other species to stock within Idaho. The budget for resident fish hatchery production is approximately 1.4 million dollars annually, not counting new construction. A major portion of hatchery reared trout and other species are stocked into hydroelectric project reservoirs to establish and maintain fisheries. Idaho Power Company has stopped stocking their reservoirs with resident trout except in one case of specific mitigation. The U.S. Fish and Wildlife Service hatchery at Hagerman previously stocked Indian reservations, federal project reservoirs and the adjacent stream sections, but is discontinuing this program. At the present time, virtually all of the burden of maintaining fisheries in the Snake River and reservoirs falls on the Idaho Department of Fish and Game and fishing license buyers.

Management Goals and Objectives

Free-flowing sections and reservoirs with suitable habitat will be managed for salmonid fisheries with annual stocking of suitable sizes and species of trout or landlocked salmon.

Reservoirs and river sections which will not support salmonid fisheries will be managed for warm water gamefish species.

Nongame fish will be controlled by chemical means or utilized by commercial fishing when economically feasible.

Remaining white sturgeon habitat will be protected and preserved.

Recommendations to Protect, Mitigate and Enhance Fishery Resources

Maintain or increase the stocking of hatchery reared trout into suitable habitat where natural reproduction is not sufficient to provide an acceptable fishery. (1.8.12)

Protect and preserve the remaining areas of suitable free-flowing river habitat for white sturgeon. (1.8.13)

Artificial propagation methods for white sturgeon are being successfully developed in California. Artificial propagation could restore sturgeon populations where natural reproduction has been limited by dams. (1.8.14)

Introduce suitable species of warm water game fish into vacant habitat which is unsuited for salmonids. (1.8.15)

Encourage development of commercial nongame fish fisheries by conducting and publishing research to inventory populations, development of fishing gear or techniques and exploring market potentials. (1.8.16)

APPENDIX C

RECOMMENDATIONS AND SUPPORTING DOCUMENTS PERTAINING TO RESIDENT FISH IN WASHINGTON

A report to the Northwest
Power Planning Council
November 13, 1981

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Introduction

In preparing these recommendations, I sought the recommendations, advice, and informed comment of many individuals who are also concerned about the forturnes of resident sport fish. The recommendations presented in Appendix C are directly related to hydroelectric development. Many other good recommendations or ideas fell out along the way because their relation to hydro power is not as clear. One group of colleagues compiled a comprehensive summation of development impacts on resident game fish. They concluded that inundation (i.e., creating a reservoir) and fluctuation (non-seasonal, frequent rise and fall of stream or reservoir levels) are the two major consequences of hydroelectric development.

The Appendix C recommendations are diverse. No effort is made to label them as to whether they fall under protection, mitigation, or enhancement. In Washington's fish and wildlife matters related to natural resource alteration (e.g., dams, irrigation, highways, etc.), the Department of Game's priorities are loss prevention (whether habitat or wildlife), then mitigation/compensation, and lastly enhancement. Natural resource alteration, where one resource is frequently developed at the expense of another, continues to escalate so that loss prevention and/or reduction demands greatest attention now. One result is that some very good fish and wildlife enhancement projects are down-graded.

To properly categorize preliminary recommendations, an outline was developed which placed several subobjectives under each of 5 main objectives. Every subobjective was assigned a code number for easy reference; for example, 1.2.3. The order in which recommendations are presented, or their code numbers, do not indicate the priority of their considered importance. The following list places the final resident fish recommendations in order of priority. Number 1 is highest priority and 12 is lowest. Priorities were assigned on the basis of worth (protection, mitigation, or enhancement), supporting documentation, and, where the choice was not clear cut, professional judgement.

Priority	Code No.	Recommendation
1.	2.1	Banks Lake Barrier Net
2.	1.2.13	Banks Lake Rule Curves
3.	1.9.7	Protection Of Waters As They Now Exist
4.	1.2.14	Mid Columbia River Reservoirs Study
5.	1.2.10	Mid Columbia River Reservoirs 2 Foot Limit On Fluctuation
6.	1.8.18	Protection Of Hanford Reach Sloughs
7.	1.8.17	Enlarged Bumping Reservoir Off-stream Storage
8.	1.1.6	Recommended Yakima River Basin Stream Flows
9.	1.2.11	Rimrock Reservoir Recommended Minimum Pool
10.	1.2.11	Keechelus Reservoir Recommended Minimum Pool
11.	1.8.19	Wells Reservoir Warm Water Fish Habitat Enhancement
12.	1.8.20	Priest Rapids Reservoir Warm Water Fish Habitat Enhancement.

Mid Columbia River Basin

Basin Description

Geography

The portion of the mainstem Columbia River often referred to as the Mid Columbia is about 420 miles long. It extends from the mouth of the Snake River to the Canadian border.

Major tributary streams of the Mid Columbia are the Snake, Yakima, Wenatchee, Methow, Okanogan, San Poil, Spokane, and Colville rivers.

Six hydroelectric projects on the mainstem Mid Columbia are discussed. They are Priest Rapids, Wanapum, Rock Island, Rocky Reach, Wells, and Chief Joseph projects.

Hydrology

The Mid Columbia River drains about 100,000 square miles, including 60,000 square miles in Canada. Annual precipitation in the Mid Columbia region averages about 9 inches. About 70 percent of this falls from October through March, mainly as snow. Summer precipitation comes mainly from thunderstorms.

Average annual stream flow for the Mid Columbia is approximately 120,000 cubic feet/second (cfs), but short term extremes have varied by a factor of 5 either way. Flow is regulated by 10 major reservoirs and numerous small reservoirs and power plants. About 4-5 percent of annual stream flow is diverted for irrigation.

Recreation

Outdoor recreation continues to increase in importance, especially in eastern Washington. Seventy five percent of Washington's population lives in the western part of the State, but half of the wildlife-oriented recreation occurs in eastern Washington. On an annual basis, approximately 120,000 anglers fish for resident sport fish in the Mid Columbia River.

Resident Fish Resources

Rainbow trout are the most important game fish in the basin. Whitefish are also important.

Among the non-salmonid game fish, walleye are the most popular. Smallmouth and largemouth bass, and also crappie populations, are increasing in numbers and popularity. Sturgeon, channel catfish, and blue catfish are most frequently caught in the southern portion of the Mid Columbia.

Project Description

Priest Rapids Project

Priest Rapids Dam and Reservoir is a Grant County PUD project at RM 397. It was completed in 1960.

The reservoir is 7,700 acres and 18 miles long, ending at Wanapum Dam. Power generation causes frequent vertical fluctuation of the reservoir of 1-5 feet.

History of Fish

For several years, kamloops trout were planted in this reservoir. Few were caught. It is known that some migrated to the ocean and then returned as adult steelhead.

Smallmouth bass are localized to specific areas but do provide some angling. Walleye are also caught. Both species have immigrated into this reservoir naturally. Mountain whitefish are natives and some can still be caught in the upper part of the project.

Impact on Fish

The slack water environment benefits warm water fish; but mountian whitefish are now found only in the upper, flowing portion of the project. Fluctuation limits reproduction and rearing. Rough fish populations are prospering in the reservoir environment.

Management Goals and Objectives

Goal: To increase overall angling opportunity while maintaining or increasing wild game fish populations.

Objectives:

1. Maintain populations of wild resident salmonids.
2. Maintain current warm water game fish populations while determining the degree of compatibility with anadromous smolts.
3. Increase harvest of warm water game fish through increased public awareness.

Wanapum Project

Wanapum Dam and Reservoir is also a Grant County PUD project. The dam is at RM 415. The Wanapum Dam and Reservoir was completed in 1963.

The reservoir is approximately 15,000 acres and 38 miles long, ending at Rock Island Dam. Power operations cause the reservoir to often fluctuate 1-2 feet.

History of Fish

Kamloops trout were planted in this reservoir for several years. This effort was not successful. The results were similar to those at Priest Rapids.

PUD fishery biologist found the greatest abundance of fish in the Mid Columbia reservoirs in Wanapum reservoir. Smallmouth bass and walleye are the fish which show up most often in the sport catch. Mountain whitefish are found in the flowing upper portion of the project and contribute to the sport catch. A few sturgeon are also caught near Rock Island Dam.

Impact on Fish

The reservoir environment has had the same result as at Priest Rapids. Cold water fish have declined, warm water species are on the increase, and rough fish are abundant. Frequent fluctuations degrade the habitat of resident fish, but not to the degree as elsewhere.

Management Goals and Objectives

Goal: To increase overall angling opportunity while maintaining or increasing wild game fish populations.

Objectives:

1. Maintain populations of wild resident salmonids.
2. Maintain current warm water game fish populations while determing degree of compatibility with anadromous salmonids.
3. Increase harvest of warm water game fish through increased public awareness.

Rock Island Project

Rock Island Dam and Reservoir is owned and operated by Chelan County PUD. The dam is at RM 453. The reservoir is 21 miles long and approximately 3,500 acres in size. Frequent fluctuation due to power operations is 2-4 feet.

Rock Island was the first major dam on the Columbia River. The project was completed in 1933 by Washington Electric Co. and Puget Sound Power and Light Co. and later was acquired by Chelan. The reservoir elevation has been increased 3 times since original construction: 4 feet in 1951, 3 feet more in 1953, and 6 additional feet in 1978.

History of Fish

As with other Mid Columbia reservoirs, mountain whitefish were abundant before reservoir creation. Fishing for whitefish is still a popular winter pasttime in the vicinity of the Wenatchee River mouth and in the riverine upper project area.

Walleye fishing is increasing in popularity and is concentrated in the upper half of the project. There is no significant population of smallmouth bass.

Rough fish are abundant, especially in the downstream half of the reservoir.

Impact on Fish

The Rock Island project is the least reservoir-like of those on the Mid Columbia River. But here also, cold water sport fish are reduced in habitat and numbers, warm water sport species are on the increase, and rough fish dominate.

Management Goals and Objectives

Goal: To increase overall angling opportunity while maintaining or increasing wild game fish populations.

Objectives: 1. Maintain populations of wild resident salmonids.

2. Maintain current warm water game fish populations while determining degree of compatibility with anadromous salmonids.
3. Increase harvest of warm water game fish through increased public awareness.

Rocky Reach Project

Rocky Reach Dam and Reservoir is a Chelan PUD project located at RM 474. This facility has been operating since 1961.

The reservoir is 10,000 acres and is 42 miles long, ending at Wells Dam. Power operations cause Rocky Reach reservoir to frequently fluctuate 1-2 feet.

History of Fish

A good walleye fishery is developing in the upper end of this project (Wells Dam tailwater). Also at the mouth of the Chelan River. Some mountain whitefish are also caught in the upper half of the project. These are the only significant resident sport fisheries. Rough fish abound throughout this reservoir.

Impact on Fish

Rocky Reach has experience the same habitat and populations changes as the previously discussed Mid Columbia reservoirs. The native cold water fish have diminished, warm water sport fisheries are developing, and coarse fish dominate the overall population. Reservoir fluctuation limits reproduction and rearing of resident sport fish.

Management Goals and Objectives

Goal: To increase overall angling opportunity while maintaining or increasing wild game fish populations.

Objectives:

1. Maintain populations of wild resident salmonids.
2. Maintain current warm water game fish populations while determining degree of compatibility with anadromous salmonids.
3. Increase harvest of warm water game fish through increased public awareness.

Wells Project

Douglas County PUD owns and operates Wells Dam and Reservoir, located at RM 516. Wells was completed in 1967.

The reservoir is 10,000 acres and 29 miles long, ending at Chief Joseph Dam. The reservoir fluctuates 1-8 feet from hydro operations.

History of Fish

Prior to Wells reservoir, the principal resident sport fish in the project area were mountain whitefish. Whitefish are now fewer in numbers and confined to river-like areas in the project. Warm water sport fish are on the increase. Walleye provide a popular fishery at a number of places in the project. Largemouth bass, smallmouth bass, crappie, and perch are also caught. Rough fish dominate the overall fish population.

Impact on Fish

Inundation of the free-flowing Mid Columbia River created vast changes in fish habitat. The slack water habitat benefits warm water game fish; rough fish benefit from it even more. Native game fish, mainly whitefish, are now found only in the reservoir's riverine part. Fluctuation from power operations degrades the present reservoir habitat for all fish.

Management Goals and Objectives

Goal: To increase overall angling opportunity while maintaining or increasing wild game fish populations.

Objectives:
1. Maintain populations of wild resident salmonids.
2. Maintain current warm water game fish populations while determining degree of compatibility with anadromous salmonids.
3. Increase harvest of warm water game fish through increased public awareness.

Chief Joseph Project

Chief Joseph Dam and Reservoir is a Corps of Engineers project at RM 545. It was completed in 1955.

The reservoir is 8,000 acres and 53 miles long, ending at Grand Coulee Dam. Power generation causes frequent reservoir fluctuation of 5-8 feet or more.

History of Fish

There has been no resident fish mitigation whatsoever for construction impacts of Chief Joseph Project. Walleye and rainbow trout are fairly common in the reservoir. Kokanee are taken by boaters trolling in the dam's forebay. Brown trout, brook trout, ling, sturgeon, and perch are also present but seldom show up in the catch.

Impact on Fish

Coarse fish thrive in the reservoir environment. The areas where desirable spawn, rear, or are caught are often exposed by reservoir fluctuation. This dampens overall fish productivity.

Management Goals and Objectives

Goal: To increase overall angling opportunity while maintaining or increasing wild game fish populations.

Objectives: 1.Maintain or increase wild rainbow trout population.

2.Increase kokanee population and harvest.

3. Increase and diversify angling opportunity.

Recommendations to Protect, Mitigate, and Enhance Fishery Resources

TO ENHANCE SUCCESSFUL REPRODUCTION AND REARING, THE WATER LEVELS OF MID COLUMBIA RIVER RESERVOIRS SHOULD FLUCTUATE 2 FEET OR LESS IN ELEVATION, MARCH THROUGH AUGUST (RESERVOIR DISCHARGE SHOULD NOT BE REGULATED FOR NEW AND FUTURE HYDRO-GENERATION AT THE EXPENSE OF FISHERY NEEDS). (1.2.10)

Documentation

Resident game fish in the Mid Columbia River would benefit from seasonally restricted reservoir operating ranges through (1) increased spawning success, (2) an increased supply of vertebrates as a food source, and (3) increased aquatic vegetation which would benefit both spawning and invertebrates.

Restricting daily hydro-caused water level fluctuations to 2 feet from March through August will protect game fish reproduction (Bell 1971, Watson 1955). Smallmouth bass nests and fry are especially vulnerable to water level fluctuations and accompanying water temperature changes (Henderson and Foster 1956, Montgomery et al 1980). Henderson and Foster linked poor smallmouth bass spawning success to water level fluctuations. Less fluctuation will increase spawning success.

A reduction in invertebrates, caused by fluctuating water levels, was injurious to sport fisheries in the Snake River (Kroger 1973). Invertebrates, which are important in the food chain of fish, can be reduced by water level fluctuations in 3 ways. First, fluctuating water levels reduce aquatic

vegetation (Falter et al 1972). A reduction of vegetative cover reduces invertebrate habitat and the prey of invertebrates (Dendy 1946, Grimas 1962, Hunt and Jones 1968). Second, flow rate changes and periodic stranding alter invertebrate habitat so that they can no longer survive there (Kroger 1973, Brusven et al 1974, Trotzky and Gregory 1974, Brusven 1975, Hildebrand 1980). And third, high or changing water velocities sweep invertebrates downstream and significantly reduce their populations (Brusven et al 1974, Trotzky and Gregofy 1974, Brooker and Hemsworth 1978). Seasonally restricted reservoir operating ranges will provide a more stable environment for invertebrate growth and survival. An increased food supply means better fish growth and survival.

Although sufficient light for aquatic vegetative growth in the Columbia River reservoirs extends down to 12 feet, most growth is limited to within 8 feet of the surface. Therefore, a productive zone in river reservoirs is reduced by fluctuating water levels as its upper limit and available light as its lower limit (Falter et al 1972). Reduction of the vegetative zone negatively impacts fish spawning (Il'ina and Gordeyer 1972) and invertebrate habitat (Grimas 1962). Reductions in water level fluctuations would reduce the amount of vegetative zone impacted. In other words, fish habitat and habitat of fish food would increase.

IT IS RECOMMENDED THAT SLOUGH AND EMBAYMENT SPAWNING AND REARING AREAS IN THE HANFORD REACH OF THE MID COLUMBIA RIVER BE PROTECTED FROM FLUCTUATING RIVER FLOW BY DIKING AND OTHER APPROPRIATE MEASURES, AND THAT CONSIDERATION FOR PROTECTION OF SUCH SPAWNING AND REARING AREAS BE INCORPORATED INTO MID COLUMBIA RIVER HYDROELECTRIC PLANNING AND OPERATIONS. (1.8.18)

Documentation

For Description of Hanford Reach, see 1.9.7.

Over 90 % of the smallmouth bass production in the Hanford Reach occurs in four major sloughs (Zook 1980). Montgomery et al (1980) and Watson (1955) found

that stable water levels in spring and early summer are necessary for successful spawning of smallmouth bass. As a result of water level fluctuations (6-10 feet) caused by hydro power operations, these sloughs experience temperature changes and fry and ad-lt smallmouth bass also become vulnerable to entrapment and stranding.

Thermal shock from sudden intrusions of colder river water are also damaging. This occurs with hydro peaking. Emig (1966) reported that smallmouth bass are responding to a water temperature threshhold when moving into sloughs for spawning. Spawning begins at a higher temperature range. But an abrupt drop in water temperature causes nesting to stop. Henderson and Foster report that cold water flushing through slough spawning areas in the Hanford Reach prevented hatching of bass eggs.

Rapidly dropping river level has trapped bass in the sloughs, adults as well as young. In some instances, the fish were trapped permanently. An increase in predation on young bass by adults resulted, and then dessication of all. Since fry are more susceptible to stranding than adult fish, a major drop in river flow when young fish are at peak abundance (usually in spring and summer) would have the greatest impact on population.

Less severe water level fluctuation in the Hanford slough areas accounted for greater egg hatch and fry survival (Montgomery et al).

Bell (1971) and other authors (Smetanich 1961, Berval'd 1970) suggest the possibility of constructing sills and protective diking around sloughs and embayments to stabilize water levels and temperature for protection and enhancement of fish reproduction and rearing.

IT IS RECOMMENDED THAT ARTIFICIAL WARM WATER FISH HABITAT, SUCH AS REEFS, GRAVEL BLANKETS, BRUSH PILES, AND OTHER APPROPRIATE MEASURES BE CONSTRUCTED IN THE VICINITY OF THE OKANOGAN RIVER IN WELLS RESERVOIR. (1.8.19)

Documentation

Wells Reservoir has a diverse but seemingly limited population of warm water game fish. Walleye, largemouth bass, smallmouth bass, crappie, and perch are present. Perusal of literature suggests that experimenting to develop several limited but definite areas of improved habitat is well worth trying. Habitat design should attempt to satisfy as many life history needs as possible. Habitat characteristics to consider are: where do they spawn, what is the bottom substrate, is cover required, how deep; what are escape or protection requirements, do they prefer deep or shallow areas.

In Utah, largemouth bass spawned on gravel or rocky bottoms, in 1.5 to 27 feet of water, adjacent to cover such as islands or reefs. Crappie also readily use such habitat for spawning (Miller and Kramer 1970). Walleye in Oklahoma and Washington frequent gravelly or rocky areas in shallow water for spawning and other activities (Grinstead 1970, Fielder 1977). Smallmouth bass in Washington often use gravel bottom sloughs for spawning (Eldred, personal observation). Perch will use inundated or submerged brush piles for spawning (Beckman and Elrod 1970). These various spawning habitat characteristics also satisfy rearing and survival habitat requirements for food, protection, and space.

This recommendation's intent is to develop multi-purpose habitat. If such habitat improvement is successful on a limited basis, the concept could be applied more widely.

IT IS RECOMMENDED THAT SLOUGHS AND/OR EMBAYMENTS BE CONSTRUCTED IN PRIEST RAPIDS RESERVOIR TO ENHANCE SMALLMOUTH BASS SPAWNING AND REARING HABITAT. (1.8.20)

Documentation

It is desirable to try to increase spawning habitat for certain warm water

game fish in Mid Columbia River reservoirs. Smallmouth bass have been present in undetermined numbers in Priest Rapids reservoir since the mid 1960s. But the population does not appear to have expanded to occupy habitat throughout the reservoir. It appears to be limited to certain locations in this reservoir.

Smallmouth are found in the Buck Shot Ranch area of Priest Rapids reservoir. Several embayments or sloughs were created at the Buck Shot site when the reservoir was created. Bass use these sheltered sloughs for spawning and fry rearing. These sloughs have gravel and mixed gravel bottoms, with grass and other aquatic plants growing from the bottom. Slough depth and cover are sufficient to protect bass nests and fry from dewatering by reservoir fluctuation. Because of relative shallow depth, it is not known to what degree nests may be disrupted by wave turbulence. And it is uncertain as to the sufficiency of escape cover for fry.

Literature clearly indicate that sloughs or embayments of sufficient depth (minimum of 5 feet at all times), with a gravel or mixed gravel bottom, offering protective cover for spawning adults and fry are common ingredients of good reproductive habitat for the species of warm water game fish which populate the Mid Columbia reservoirs (Zook 1980, Beckman and Elrod 1970, Montgomery et al 1980, Grinstead 1970, Fielder 1977, Miller and Kramer 1970, Eldred-personal observation). If spawning habitat is a limiting factor, and if wider distribution of bass and other game fish is desired, then suitable additional spawning habitat should be created. That is what this recommendation proposes.

TO ENHANCE AND MANAGE A SIGNIFICANT FISHERY IN MID COLUMBIA RIVER RESERVOIRS, THE RELATIONSHIP BETWEEN RESERVOIR OPERATIONS AND FISH SURVIVAL, REPRODUCTIVE SUCCESS, AND PRODUCTION MUST BE DELINEATED. IT IS RECOMMENDED THAT STUDIES BE INITIATED TO: 1) ASSESS THE EXISTING HABITAT SUITABILITY FOR SPAWNING, REARING, FOOD, AND COVER REQUIREMENTS AND HYDROLOGICAL, LIMNOLOGICAL, AND WATER QUALITY CONDITIONS FOR SPECIES NOW PRESENT AND THOSE BEING CONSIDERED FOR POSSIBLE INTRODUCTION; AND 2) DETERMINE THE MOST FEASIBLE METHODS TO IMPROVE HABITAT SUITABILITY OR INCREASE HABITAT AVAILABILITY FOR DESIRABLE SPECIES CONSIDERING PARTICULAR SPECIES NEEDS, PROJECT OPERATIONS, COST AND OTHER CONSTRAINTS. (1.2.14)

SPECIFIC STUDY OBJECTIVES ARE:

1. DETERMINE IF FOOD PRODUCTION IS ADEQUATE TO INSURE SUFFICIENT SURVIVAL AND GROWTH OF GAME FISH IN THE MID COLUMBIA RIVER RESERVOIRS AND (IF NECESSARY), INVESTIGATE METHODS TO IMPROVE. METHODS TO INCREASE FOOD PRODUCTION MAY INCLUDE STABILIZING WATER LEVELS TO ENCOURAGE ESTABLISHMENT OF A LITTORAL ZONE, PROVIDING ARTIFICIAL SUBSTRATE TO INCREASE FOOD PRODUCTION, OR OTHER WAYS.

2. IDENTIFY AREAS AND DETERMINE WATER LEVELS NECESSARY TO PROVIDE SPAWNING AND REARING HABITAT FOR GAME SPECIES. A SURVEY SHOULD BE DONE TO COMPARE SHORELINE TOPOGRAPHY, WATER LEVEL FLUCTUATIONS, AND POTENTIAL LITTORAL DEVELOPMENT.

3. DELINEATE IMPORTANT RESERVOIR AND TRIBUTARY SPAWNING HABITATS AND IMPLEMENT (IF APPROPRIATE) MEASURES TO ENHANCE GAME FISH REPRODUCTIVE SUCCESS IN MID COLUMBIA RIVER RESERVOIRS.

4. DETERMINE IF WATER QUALITY IN MID COLUMBIA RIVER RESERVOIRS IS ADEQUATE FOR SURVIVAL, GROWTH, AND REPRODUCTION OF DESIRABLE FISH SPECIES.

Documentation

Resident fish populations in the Mid Columbia River reservoirs potentially offer a large recreational outlet. These hydroelectric reservoirs possess good possibilities for resident fish management, but only if we know something about these reservoirs, their fish, and the fish can be utilized by the fishing public. Present information on resident fish in the Mid Columbia is minimal, sporadic, and lacks continuity. The first step should be to see what we have, how much, and where it is.

Little detailed and area specific life history information exists on resident game fish in the Mid Columbia River reservoirs. After learning "what, how much, and where" about the resident fish, we need to know why it's there, what it's doing there, and what are the factors limiting it. Answers to these questions lead toward resident fish management alternatives.

Modification of the Mid Columbia from river to reservoirs may have created niches for new fish species (Erickson et al 1976). Habitat criteria and limiting

factors for potential introductions need study; the suitability of the Mid Columbia for survival and growth of these potential new populations also needs examination. The positive and negative aspects of possible introductions into the reservoir system requires close scrutiny (Jester 1971).

BANKS LAKE

Description

Geography and Hydrology

Banks Lake is an impoundment in eastern Washington. It is 29 miles long and is contained between two earthfill dams in the upper Grand Coulee, an Ice Age channel of the Columbia River.

The high pool surface area of Banks Lake is 27,000 acreas. Water is released at the south end to irrigate 500,000 acres of farmland in the USBR Columbia Basin Project. The maximum rate of irrigation release is 9,900 cfs. Two new hydro power plants on the outlet Main Canal will be under construction in the near future. USBR will begin operating a hydro pump-generating power plant at the north end inlet soon.

Precipitation averages 11 inches annually, mainly as snow. An ice cover, usually remaining 1-3 months, develops on this lake in severe winters.

Fisheries

Banks Lake has a diverse fish community. The origin of many of these fish stocks is Franklin D. Roosevelt Lake, from which the fish were pumped into Banks Lake.

Kokanee is the most important game fish in Banks Lake. Perch fishing is an

important winter recreation. Other game fish in Banks Lake are rainbow trout, lake whitefish, largemouth bass, walleye, and crappie.

Banks Lake has the premier kokanee fishery in the State of Washington, perhaps in the Northwest. These fish are landlocked sockeye salmon, but are as bright and vigorous as salmon rearing in the sea. Banks Lake kokanee are significantly larger than those in many other waters. The bulk of those caught by fishermen are 12 to 20 inches in length and weigh 1 to 3 pounds. The Banks Lake kokanee fishery has greatly increased in popularity over the past 15 years. In 1965, 29,000 angler-days were spent in fishing for Banks Lake kokanee (Spence 1965). The fishery has increased over time; 92,000 angler-days in 1972 (Duff 1972), 78,000 in 1976 (Stober 1977), and approximately 80,000 in 1980. This fishery contribution to the annual State economy has grown from $72,500 in 1965 to about $5 million in 1980.

Recreation

Banks Lake is one of the finest recreation waters in the State of Washington. Average annual fishing usage is approximately 70,000-80,000 angler-days. Annual total participant expenditures have increased from about $3 million to about $5 million in the last 5 years. The area is also important for its good hunting and non-consumptive recreation values.

Management Goals and Objectives

Goal: To increase overall angling opportunity while maintaining or increasing wild game fish populations.

Objectives: 1. Maintain or increase kokanee sport fishery annual harvest at 70,000 fish or more of an average size of 13 inches in length or greater.

2. Increase angler opportunity and species diversity.

a. Annual rainbow trout plants of 150,000 fish.

b. Introduce lake trout and smallmouth bass.

3. Increase utilization of lake whitefish.

4. Increase perch, walleye, and burbot production.

Recommendations to Protect, Mitigate, and Enhance Resident Fishery Resources

IT IS RECOMMENDED THAT A BARRIER NET BE PROVIDED, OPERATED, AND MAINTAINED AT THE OUTLET INTO THE MAIN CANAL AT BANKS LAKE. THIS WILL PREVENT THE OUTMIGRATION OF KOKANEE, CONSERVE THEIR SPAWNING POPULATION, AND INCREASE THE NUMBER OF FISH AVAILABLE FOR SPORT HARVEST. (2.1)

Documentation

Kokanee have a definite inclination to migrate out of a lake or reservoir if possible. Banks Lake kokanee are no exception. In the course of studying the aquatic ecology of Banks Lake, Stober (1979a) estimated about 60 % of each year's mature kokanee population left Banks Lake via the main irrigation canal. Various means were considered to reduce this outmigration. It was decided to try an experimental barrier net, rather than other alternatives which were either much more costly or would hinder irrigation water outflow.

To determine the effectiveness of the barrier net, Stober studied the extent of outmigration for four years. Two years without the net were compared to two years with the net in place. Without the net, 60 % of the adult kokanee left Banks Lake. With the barrier net, loss through migration was reduced to 25 % the first year, and 4 $ the next.The barrier net has shown to be a practical and economical way of reducing the outmigration of fish from Banks Lake. As outmigration is reduced, kokanee reproduction and harvest are sustained at desirable levels.

But now a significant new factor has been added. Two proposed hydro projects on the outlet canal of Banks Lake have been licensed by FERC. All fish leaving Banks Lake will pass through the hydro plants. An undetermined amount of loss will occur from this passage. Bell (1980) estimated fish loss from passing through generating units at each plant would be in the range of 9 to 13 %, for fish up to 8 inches in length. A literature review did not reveal survival data for fish of such large size. A tentative estimate, based on professional experience, is that survival would not exceed 75 % at each plant. Prior to the barrier net experiment, fish leaving Banks Lake have provided a popular fishery downstream. Now, after passing through two hydro power plants, the downstream fishery would be reduced 40 to 50 %, at a minimum. The Banks Lake fishery would be in jeopardy of unacceptable levels of reproduction and harvest without the previous compensating benefit of a concurrent good kokanee fishery downstream.

To preserve the Banks Lake fishery, a barrier net should be installed and maintained as a permanent feature at the outlet to the main irrigation canal.

THE SURFACE ELEVATION OF BANKS LAKE SHOULD BE REGULATED FOR HYDRO-GENERATION IN ACCORDANCE WITH THE RULE CURVES DEVELOPED BY STOBER ET AL (1977) TO PROTECT KOKANEE REPRODUCTION (RESERVOIR DISCHARGE SHOULD NOT BE REGULATED FOR NEW AND FUTURE HYDRO-GENERATION AT THE EXPENSE OF FISHERY NEEDS). (1.2.13)

Documentation

The magnitude and timing of drawdown of Banks Lake can impose a significant impact on the survival of kokanee eggs and fry. Small adult kokanee populations occurred in 1976 and 1977 which were direct results of extreme drawdowns of 24 and 25 feet in 1973 and 1974 (Stober et al 1979a). Small catches of kokanee were reported during the summer of 1976 as well as a greatly reduced entrainment of kokanee into the main irrigation canal. This outmigration of kokanee is an index

of overall population size. The outmigration declined from 128,000 in 1975 to 50,000 in 1976. Drastically reduced kokanee spawning populations were noted. In 1975, there were 7,500 spawners, which is about normal. The 1976 spawning population was only 150 (Stober et al 1977).

Stober studied the effects of these drawdowns on eff and fry survival during 1977, 1978, and 1979. Fry emergence was found to occur between April 1 and June 10 during these years. Primary spawning occurred at a range of 5 to 15 feet. This corresponds to elevations of 1565 to 1555 feet above mean sea level (normal full reservoir is 1570 feet). Secondary spawning occurred down to 22 feet (1548 feet above msl), but only with larger than normal spawning populations of kokanee. Drawdown limits (rule curves), which safeguard eggs and fry, were developed from this data by Stober. The timing of the rule curves is temperature dependent. The rule curves can be utilized to manage the rate and level of drawdown each year to allow 75 percent of the eggs and fry to survive and emerge from the gravel, provided the timing of emergence is known. The rule curves can be utilized to regulate water elevations to protect natural kokanee reproduction. They do not represent a major departure from the usual operational drawdown of the reservoir for irrigation. However, they will affect proposed hydro power generation. USBR pump-generation is scheduled to commence soon. This will probably cause Banks Lake to fluctuate between 1570 and 1563 feet during the winter. This range of drafting has the potential to cause the loss of 50 % of kokanee eggs and fry. Also, two new hydro plants on the main canal outlet, would benefit from lake discharge which exceeds irrigation needs. This also has adverse potential for kokanee reproduction. See Figure 1, page 21.

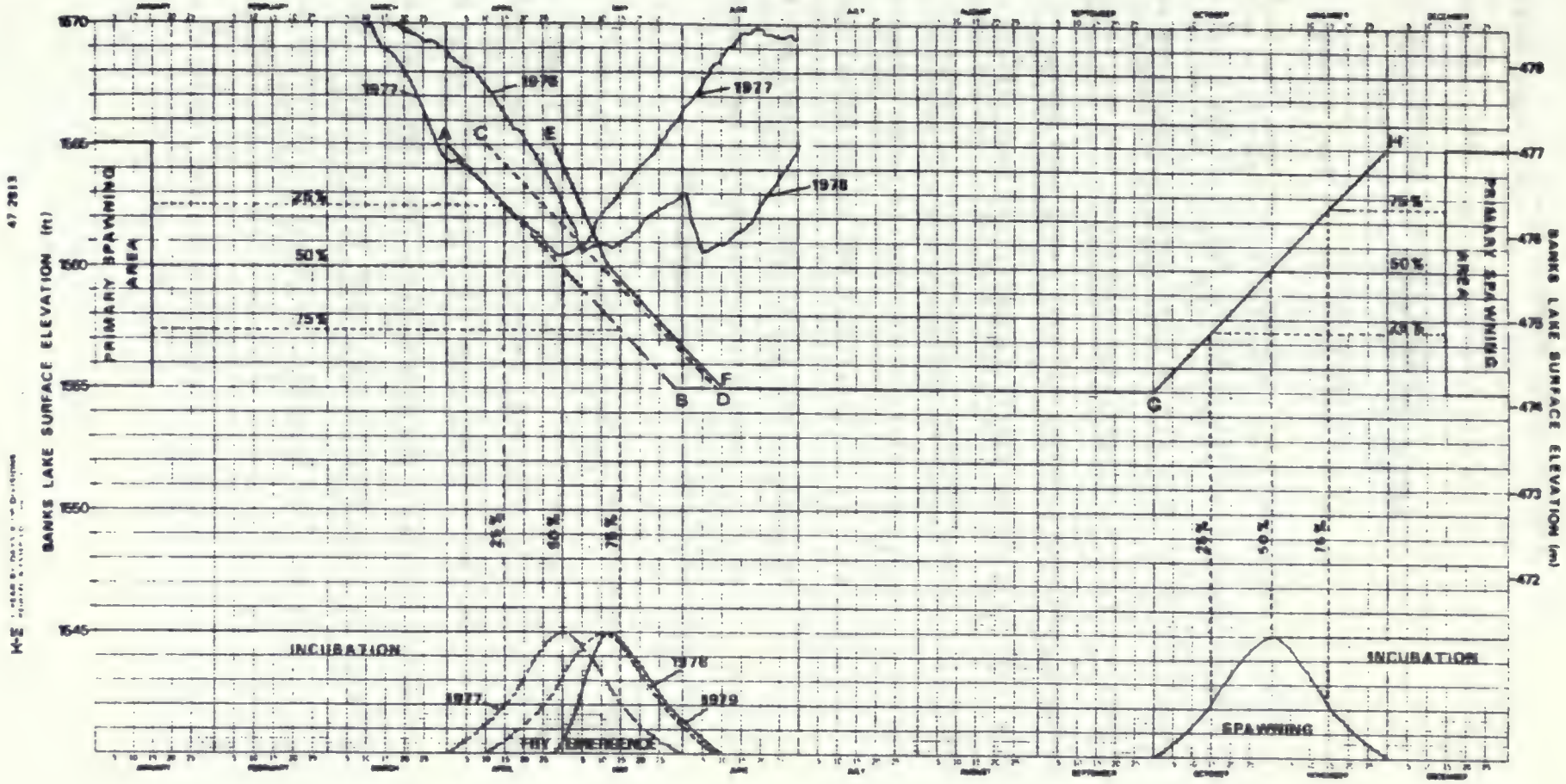

Fig. 1. Rule curves for Banks Lake drawdown to allow fry emergence from a small kokanee spawning population. Rule curves AB, CD and EF are based on 1977, 1978 and 1979 fry emergence timing; B, D, F and G indicates minimum summer drawdown and GH are the water level requirements for spawner access to the prime spawning area. Drawdown curves for spring 1977 and 1978 are shown. (Source: Stober et al. 1979b).

Description

Geography and Hydrology

The Hanford Reach of the Mid Columbia River is the last sizeable free-flowing portion of the Columbia River above the estuary. At the lower end is Richland, the headwater of McNary Reservoir; Priest Rapids Dam is at the upper end. Much of the main channel bottom is variously large cobbles or mixed sand and gravel. In some areas there are rock outcroppings or clay formation. The banks are alternately cobbles, sand bars, ancient alluvial fans, sand dunes, or steep cliffs. Much of the peripheral land slopes gently to the river. Many islands occur through this reach, some as bare gravel bars and others supporting cheatgrass, sagebrush, and willows. The major island complex is at RM 370, the Locke Island group.

The watershed upstream of Hanford covers 97,000 square miles. Mean annual flow is 120,000 cfs. Extreme record flows are 693,000 cfs (1948) and 4,100 cfs (1932). Average water velocity is approximately 9 miles per hour. Deeper water away from the bank varies from 5 feet to 35 in depth.

Fisheries

Smallmouth bass, mountain whitefish, rainbow trout, sturgeon, and channel catfish are the most important resident sport fish. Largemouth bass, perch, crappie, blue catfish, and flathead catfish are caught also. Four sloughs are collectively the primary smallmouth bass spawning habitat (Zook 1980). Islands, bars, and backwaters are also important fish habitat. Montgomery et al (1980) state that the large (6-10 feet) frequent fluctuations of river surface are detrimental to smallmouth bass production; and that these fluctuations are the result of hydropower

peaking at Priest Rapids Dam.

Parenthetically, the Hanford Reach is the last major mainstem Columbia River spawning area of steelhead and fall chinook.

Recreation

The nature of the Hanford river environment offers recreationists a unique outdoor experience. That approximately 50 miles of a major river have escaped much of the perturbation that many other areas evidence seems amazing to many observers. This area is very popular with fishermen, hunters, and other outdoor people. A recent Washington Department of Game survey over one year found that 34,000 fishermen caught 35,000 steelhead, resident trout, whitefish, bass, walleye, catfish, and sturgeon. Participants contributed $1.2 million to the State economy. In addition, 27,000 people fish for salmon. This area is so popular that the Washington Department of Game has shortened the fishing season; the increasing human presence has become a wildlife disturbance factor.

Management Goals and Objectives

Goal: To increase overall angling opportunity while maintaining or increasing wild game fish populations.

Objectives:

1. Maintain population of mountain whitefish at current levels.
2. Maintain wild trout population.
3. Maintain or increase smallmouth bass population
4. Maintain current population of other warm water game fish and determine degree of compatibility with anadromous salmonids.

Snake River--Asotin Project Area

Description

Geography and Hydrology

The section of the Snake River that would be affected by the construction of Asotin Dam and Reservoir extends upstream from the town of Asotin, Washington (RM 146) 26 miles to China Gardens damsite (approximately the Washington-Oregon border). The Asotin Project area of the Snake River has a mean annual stream flow of about 36,000 cfs from a watershed of 93,000 square miles. This area is the last free-flowing portion of the lower Snake River.

This section lies in the Grand Canyon of the Snake River. The large, swift stream is contained by arid slopes that rise 5,000 feet or more to forested plateaus.

Fisheries

This part of the Snake River is top quality habitat for the following resident game fish: smallmouth bass, channel catfish, white sturgeon, mountain whitefish, rainbow trout, largemouth bass, and crappie. All are abundant, except largemouth bass and crappie, which are not swift water fish.

Runs of steelhead trout, chinook and coho salmon also use the Snake River.

Recreation

An estimated annual recreation use of about 200,000 visitor-days take place in the area of the proposed Asotin Dam and Reservoir. Construction of Asotin Dam would eliminate the qualities that attract outdoor enthusiasts. Fishing, hunting, and other water-oriented recreation would be radically downgraded.

Management Goals and Objectives

Goal: To increase overall angling opportunity while maintaining or increasing wild game fish populations.

Objectives: In development.

Wenatchee River

Description

Geography and Hydrology

The Wenatchee River originates as outflow from Lake Wenatchee in the Cascade Mountains. It flows 54 miles to enter the Mid Columbia River at the city of Wenatchee. Major tributaries include Mission Creek, Peshastin Creek, Chumstick Creek, Icicle Creek, Chiwaukum Creek, Chiwawa River, and Nason Creek.

The Wenatchee River Basin covers 1,300 square miles. Mean annual flow is about 3,100 cfs. The Wenatchee is a snowmelt stream with most of its yield occurring in the spring.

Chelan County PUD has proposed rehabilitating two decommissioned small hydro projects on the Wenatchee, one at the town of Dryden and the other in Tumwater Canyon.

Fisheries

Mountain whitefish, rainbow trout, and Dolly Varden are the principal resident game fish. Washington Department of Game has introduced brown trout in the hope this dpecies will become established and self-sustaining. Dept. of Game plants approximately 60,000 rainbow trout in the Wenatchee River system each year. This program provides an extremely popular fishery, amounting to about 25,000 angler-days annually.

The river provides spawning and rearing habitat for not only resident game fish but several anadromous species as well. The US Fish and Wildlife Service Leavenworth National Fish Hatchery is primarily committed to spring chinook propagation. And the Wenatchee River system contributes about 40 % of the Columbia River's sockeye salmon production.

Recreation

The Wenatchee Basin provides a wide variety of outdoor recreation opportunities. Fishermen, hunters, and other wildlife enthusiasts have streams and lakes, arid sagebrush slopes and forested mountains, developed campgrounds and wilderness area for leisure pursuits. The US Forest Service reports 228,000 visitor-days in the Tumwater and Icicle campgrounds in 1981. Lake Wenatchee State Park had 231,000 visitors during the 1981 summer season. Fishing for resident game fish accounted for 40,000 angler-days.

Management Goals and Objectives

Goal: To increase overall angling opportunity through stocking of hatchery origin trout, while maintaining or increasing wild populations.

Objectives: In development.

Methow River

Description

Geography and Hydrology

The Methow River rises in the east slope of the Cascade Range and flows south and east for 83 miles to join the Mid Columbia River at the town of Pateros. Major tributaries are Gold Creek, Beaver Creek, Twisp River, Chewack River, Early Winters

Creek, and Lost River. The Methow River Basin takes in an area of 1,800 square miles. The mean annual flow of the Methow River is 1,555 cfs.

The National Hydroelectric Power Study performed by the US Army Corps of Engineers identified 5 potential hydropower sites in the Methow system.

Fisheries

The Methow River could be described as a classic trout stream. Rainbow and cutthroat trout, brook trout, mountain whitefish, and Dolly Varden inhabit this system. Wash. Dept. of Game plants about 30,000 rainbow trout each year in the Methow River. The trout provide the bulk of the catch in summer, and whitefish offer a popular winter fishery.

In 1915 a dam was constructed near Pateros, which prevented anadromous fish from returning upstream. It was removed in 1930 but the runs had difficulty recovering naturally. Various attempts to reestablish anadromous fish have been made by state and federal agencies. The US Fish and Wildlife Service reported a run of 2,800 adult chinook in 1967. The annual steelhead sport catch ranges from 1,000 to 2,000. The majority of these are returns from Wash. Dept. of Game hatchery production.

Recreation

Information about outdoor recreation is limited. The combined Methow River and Okanogan River basins provide about 400,000 user-days of consumptive and non-consumptive recreation related to fish and wildlife each year. This equates to participant expenditures totalling about $15 million annually.

Management Goals and Objectives

Goal: To increase overall angling opportunity through stocking of hatchery origin

trout, while maintaining or increasing wild populations.

Objectives: In development.

Similkameen River

Description

Geography and Hydrology

The Similkameen River originates in Washington, flows north into Canada, and later recrosses the international boundary about 129 miles from its source. It continues another 27 miles to empty into the Okanogan River near the town of Oroville. Major tributaries are Sinlahekin Creek, Toats Coulee Creek, and Palmer Creek. The watershed of the Similkameen River covers approximately 3,000 square miles in Canada and about 400 square miles in Washington. Mean annual flow is 770 cfs as measured at the USGS gaging station near the lower crossing of the Canadian border.

Four potential hydro sites were identified by the Corps of Engineers National Hydroelectric Power Study. Okanogan County PUD has applied to FERC for a license to restore and operate the decommissioned Enloe Dam hydro facility.

Fisheries

This river offers superior salmonid habitat, both for resident species and anadromous. Trout species include rainbow, brook, cutthroat, and brown. Mountain whitefish are also present. Wash. Dept. of Game has planted 10,000 rainbow trout annually. The trout provide summer fishing and whitefish offer winter angling.

In 1977 approximately 1,100 summer chinook salmon returned to spawn in the lower Similkameen River below Enloe Dam. Anadromous fish can not move upstream past Enloe Dam for lack of a fish ladder. Present anadromous fish runs are

significantly lower than previous levels. The State of Washington, in cooperation with USBR, is planning to establish steelhead and chinook in the Similkameen system, with passage facilities at Enloe Dam.

Recreation

In combination with the Methow River Basin, the Okanogan River Basin (of which the Similkameen River is part) shares an annual 400,000 user-days of fish and wildlife-related recreation. Total participant expenditures amount to approximately $15 million yearly.

Management Goals and Objectives

Goal: To increase overall angling opportunity through stocking of hatchery origin trout, while maintaining or increasing wild populations.

Objectives: In development.

Recommendations to Protect, Mitigate, and Enhance Resident Fishery Resources

IT IS RECOMMENDED THAT RESIDENT GAME FISH POPULATIONS AND HABITAT BE PROTECTED BY THE PROHIBITION OF CONSTRUCTING NEW HYDROELECTRIC PROJECTS, OR THE RESTORATION OF DECOMMISSIONED OR ABANDONED ONES ON THE FOLLOWING STREAMS: MID COLUMBIA RIVER--HANFORD REACH; SNAKE RIVER--ASOTIN PROJECT AREA; WENATCHEE RIVER; METHOW RIVER; AND SIMILKAMEEN RIVER. (1.9.7)

Documentation

Resident game fish are clearly the most popular part of Washington's freshwater fisheries. Among fishermen licensed by the Wash. Dept. of Game, 90 % fish for resident game fish.

All wildlife, fish as well as game, are dependent on habitat. Their diversity and abundance is directly related to the quality and quantity of these habitats.

When habitat is altered or destroyed, fish or wildlife decline or disappear, and other species occupy the new niches. People are subject to the same dynamics. Experienced fishermen usually make a respectable catch when on a live stream or lake of small to medium size. Even the inexperienced usually catch a fish or two. When streams are changed to large, deep reservoirs, experienced fishermen usually have difficulty and must learn new techniques. Inexperienced fishermen go elsewhere or take up other pursuits. When habitats are changed, it's usually because one resource has been developed at the expense of another.

On the Mid Columbia River, much of the original river habitat and fish have disappeared because of hydroelectric development projects. Seven dams have transformed 350 river miles into 132,000 reservoir acres. Only 57 miles of free-flowing river remain (the Hanford Reach). Even these are affected by dams at either end. Rough fish species dominate the reservoirs because they are better suited to the changed habitat. Native river fish are confined to the Hanford Reach or the tailwaters of dams.

On the Snake River, the Asotin Project area is all that remains of the native river; 30 miles is all that remains between Wyoming and Pasco.

Of all the electric energy produced in the Pacific Northwest, more than 50 % is generated in the State of Washington. Apparently Washington's citizens enjoy (or suffer, depending on one's point of view) more electric energy development than people of other Northwest states. Because of the great rush to develop previously by-passed hydro sites, it is wise to also identify resources which should not be developed.

The five streams which are recommended for preservation as they now exist have important fisheries and/or enhancement potential. These waters should be protected. They do not constitute a total protection list, but they do command

top priority.

Yakima River Basin

Basin Description

Geography and Hydrology

The Yakima River is located in southcentral Washington and enters the Columbia River at RM 335 near Richland. The Yakima River is 216 miles long. The Yakima River drains 6,900 square miles. Annual precipitation ranges from 10-140 inches, much of it occuring as snow. Average annual runoff for the basin is about 3-4 million acre-feet.

There are 5 large, mountain irrigation storage reservoirs, 8 diversion dams, two existing power plants, and approximately 500,000 acres under irrigation in the Yakima Basin. About 12 additional small hydro plants have been proposed. The majority would retro fit generating units into existing dams. One sizeable hydrogeneration reservoir has been proposed. All have the potential to affect stream flows.

Fisheries

The reservoirs contain mountain whitefish, kokanee, rainbow and cutthroat trout, Dolly Varden, lake trout, brook trout, and burbot (ling).

The rivers offer rainbow, cutthroat, and brown trout, Dolly Varden, brook trout, mountain whitefish, bluegill, smallmouth and largemouth bass, crappie, perch, and channel catfish.

Fluctuating (regulated) flows, high water temperature, sediments from agriculture, pesticides, and bacteria all present problems for fish.

Recreation

The Yakima Basin's recreational resources accommodate 3.5-4.0 million user-days of water-related recreation annually. Participants come from a wide area to use the natural resources: mountain terrain, forested areas, numerous bodies of water, and an abundance of fish and wildlife. Participant recreation expenditures for the basin were estimated to be $.9 million in 1969. Today this has increased to about $8-9 million annually.

Management Goals and Objectives

Goal: To maintain or increase, wherever feasible, sustainable wild populations while increasing angling opportunities through selective stocking of hatchery origin fish.

Objectives: In development.

Recommendations to Protect, Mitigate, and Enhance Resident Fishery Resources

IT IS RECOMMENDED THAT THE AUTHORIZED ENLARGED BUMPING RESERVOIR PROJECT BE CONSTRUCTED TO PROVIDE MAJOR ADDITIONAL STORAGE FOR MITIGATING THE DEGRADATION OF FISH STREAM HABITAT, INCREASED FLEXIBILITY IN YAKIMA RIVER BASIN WATER MANAGEMENT, AND DEVELOP ADDITIONAL HYDRO-GENERATION (RESERVOIR DISCHARGE SHOULD NOT BE REGULATED FOR NEW AND FUTURE HYDRO-GENERATION AT THE EXPENSE OF FISHERY NEEDS. (1.8.17)

Documentation

The implementation of the authorized Bumping Lake Enlargement Project would provide 324,000 acre-feet of new storage to enhance and protect stream flows for resident and andromous fish. The additional storage, already authorized for fish needs in the Yakima River Basin, would approximately meet the minimum requirements

shown in 1.1.6 (Recommended Yakima River Basin Stream Flows. The estimated annual fishing increase of 92,000 angler-days and its associated value, $1.46 million, attributed to the Enlarged Bumping Reservoir indicate that this authorized project would significantly improve Yakima River Basin stream flows. This gain does not include added value from proposed hydro-generation at Bumping Reservoir. Greatly increased storage would provide opportunity for commensurately increased energy production. There would be no conflict with fisheries, provided that Enlarged Bumping discharge is managed for fishery benefit and power is secondary.

THE FOLLOWING RECOMMENDED YAKIMA RIVER BASIN STREAM FLOWS, LARGELY REGULATED BY USBR RESERVOIR DISCHARGE, WOULD BE POSSIBLE IN LARGE PART WITH 1.8.17 (ENLARGED BUMPING RESERVOIR) AND SHOULD BE STRIVED FOR (RESERVOIR DISCHARGE SHOULD NOT BE REGULATED FOR NEW AND FUTURE HYDRO-GENERATION AT THE EXPENSE OF FISHERY NEEDS. (1.1.6)

YAKIMA RIVER	OPTIMUM (CFS)	MINIMUM (CFS)
AT MARTIN	100	35
" EASTON	285	95
"CLE ELUM	625	210
" UMTANUM	730	240
" POMONA	730	240
" YAKIMA	1260	420
" PARKER	1355	450
" PROSSER	1685	560
" KIONA	1680	560
KACHESS RIVER		
AT EASTON	90	30
TEANAWAY RIVER		
AT FORKS	100	35
CLE ELUM RIVER		
AT ROSLYN	280	95
BUMPING RIVER	90	30

NACHES RIVER	OPTIMUM (CFS)	MINIMUM (CFS)
ABOVE TIETON RIVER CONFL.	365	120
BELOW TIETON RIVER CONFL.	530	180
TIETON RIVER		
BELOW RIMROCK RESERVOIR	150	50
BELOW DIVERSION	170	55

Documentation

The already authorized enlargement of Bumping Reservoir could approximately provide the recommended Yakima River Basin stream flows shown above. Justification under 1.1.17, Enlargement of Bumping Reservoir, should be reviewed.

The recommended minimum flows, using the Montana Method (Tennant, 1976), are equal to 10 percent of the mean annual unregulated flow. Wesche (1973) found that as instantaneous flow (as a percent of mean annual flow) increased above 12.5 %, the available habitat for fish increased. Mongillo and Faulconer determined that game fish populations increased as stream flows increased. The Montana Method flows should be acceptable for both resident and anadromous fish.

Using the Montana Method of flow evaluation, Mongillo and Faulconer concluded that a total of 348,500 acre-feet of water would meet these needs. With the authorized enlargement of Bumping Reservoir, an additional 324,000 acre-feet of water will be available. Through a comprehensive management program being prepared by USBR, the deficit could be made up and provide all of the needed flow. Annual angling in the Yakima River Basin has the potential to increase by 92,000 angler-days. The potential increase in annual participant expenditures is approximately $1.46 million (Mongillo and Faulconer 1980).

RIMROCK RESERVOIR SHOULD NOT BE DRAWN DOWN BELOW A MINIMUM POOL OF 30,000 ACRE-FEET, WHICH IS IN ADDITION TO DEAD STORAGE (RESERVOIR DISCHARGE SHOULD NOT BE REGULATED FOR NEW AND FUTURE HYDRO-GENERATION AT THE EXPENSE OF FISHERY NEEDS. (1.2.11)

Documentation

Rimrock Reservoir is one of Washington's important kokanee waters. Annual harvest is about 75,000-100,000 kokanee, from 15,000-20,000 angler-days. Severely reduced water volume in Rimrock Reservoir decreases the kokanee sport catch for up to six years. Losses in sport fishing can range from minor (if a 30,000 acre-foot minimum pool is maintained) to nearly 91,000 man-days if the reservoir is completely drained. Unusually low reservoir levels reduce catch rate, even without draining. Fishery losses alone are valued at $700,000-$800,000 from a single draining.

Rimrock Reservoir has been emptied only 4 times since impoundment: 1926, 1931, 1973, and 1979. From draining in the fall of 1973 to full recovery in the summer of 1979, almost 6 years passed and 1.25 million kokanee fry were planted for loss replacement.

According to Mongillo and Faulconer (1980), when the reservoir is completely drained, 15,000 man-days of fishing are lost in the following year. In present value, this amount of angling represents $225,000 in participant expenditures. Average annual fishing effort and catch rate increased over the subsequent 6 year period (1973-1979). The reservoir was drained again in 1979, with an estimated loss of 6 million kokanee. Mongillo and Faulconer (1980) believe this represents 95-99 % of the entire population before draining. They further determined that reservoir storage which retains between 25,000 and 40,000 acre-feet is needed to preserve the fishery. The greatest rate of loss occurs below 25,000

acre-feet. To preserve the normal catch rate (over 5 fish per person per day), Mongillo and Faulconer recommend a minimum reservoir volume of 30,000 acre-feet be maintained, in addition to dead storage. This is 15 percent of total active storage. Data from the Western Reservoir and Stream Habitat Improvement Handbook (Nelson et al, 1978) indicates estimates in this range are reasonable.

The probability that reservoirs may be retro-fitted with generating units implies the potential to alter normal discharge in favor of maximum supplementary hydro-generation. Considering the dire consequences of severe reservoir drafting (e.g., hydro-generation), this sort of occurrence should be forestalled.

KEECHELUS RESERVOIR SHOULD NOT BE DRAWN DOWN BELOW A MINIMUM POOL OF 25,000 ACRE-FEET, WHICH IS IN ADDITION TO DEAD STORAGE (RESERVOIR DISCHARGE SHOULD NOT BE REGULATED FOR NEW AND FUTURE HYDRO-GENERATION AT THE EXPENSE OF FISHERY NEEDS). (1.2.12)

Documentation

Keechelus Reservoir is one of Washington's waters with a population of kokanee. It has an average-to-good fishery. Some large Dolly Varden are also caught. Mongillo and Faulconer (1980) believe Keechelus Reservoir has the recreational fishing potential of Rimrock Reservoir (75,000-k00,000 fish harvest annually). But a minimum pool of 25,000 acre-feet should be maintained to ensure a normal carry-over kokanee population and harvest rate (approximately 5 fish per person per day) (Mongillo, personal communication, 1980).

In addition to maintaining a minimum pool sufficient for fish survival, low water levels cause difficulty with boat launching. Due to Keechelus Reservoir's steep banks, the majority of fishing is from boats. The availability of its 3 boat ramps is essential to realize maximum fishing usage. In an average year, boats can't be launched on about 52 days because the reservoir drops below the

end of launching ramps. This 52 day loss represents 25-30 % of the fishing season. These ramps can become exposed anytime between July and January, with September and October being the worst. And the best time to catch kokanee is during September and October. By maintaining enough water to launch boats at all times, the potential fishing use would be increased by 25 %.

The probability that reservoirs may be retro fitted with generating units implies the potential to alter normal discharge in favor of maximum supplementary hydro-generation. Considering the dire consequences of severe reservoir drafting, this sort of occurrence should be forestalled (also see Documentation 1.2.11).

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APPENDIX D

RECOMMENDATIONS AND SUPPORTING DOCUMENTS PERTAINING TO RESIDENT FISH IN OREGON

A report to the Northwest
Power Planning Council
November 16, 1981

Prepared by
Jim Griggs
Oregon Department of Fish
and Wildlife

P.O. Box 3503
Portland, OR 97208

GENERAL SUMMARY

Virtually all streams in the Oregon portion of the Columbia Basin at one time produced anadromous fish; many still do, but impoundments (not all hydropower) added a new dimension, created a new demand, and posed new problems.

Typically, the resident population in the dammed anadromous stream could not fill the niche or respond to the increased demand from the expanded recreation days of use. Hatchery trout supplementation has been the most frequent mitigation.

Oregon anglers are trout-steelhead-salmon oriented and the resident trout fishery is by far the most popular. An angler preference survey estimated that 85% (327,000 people) of all the resident license holders who fished in 1977 had at least one trout angling trip. The same survey also indicated that stream trout fishing was somewhat preferred to lake and reservoir fishing but 46% did prefer standing waters.

Almost all of the estimated 132,700 warm water game fish anglers who bought 1977 licenses preferred lakes and reservoirs to streams.

Two major impacts on the resident fish populations from hydroproject impoundments are (1) competition from large non-game fish populations, and (2) fluctuating water levels.

Non-game fish populations (carp, chubs, shiners, dace, suckers, and squawfish) compete with more desirable species for food and space. Some are also known to be efficient predators. They reduce the number of game fish that may be produced. Their total numbers may preclude specific management programs, i.e. fingerling trout; may preclude management with particular game fish species; and in some situations may negate any meaningful management program.

All reservoirs fluctuate; to what degree is due to project authorization and/or design. Those including flood control normally have a major fluctuation and impact resident fish populations most:

(1) Shoal area is the most productive and is the first to be dried out as water is pulled.
(2) Erosion is more extensive because of unstable shorelines.
(3) Stocking rates (except for legal-sized fish) are normally based on minimum pools, yet angling usually occurs on maximum pools.
(4) Fluctuation is often at such a time to either dewater or submerge spawning areas.

Several of the hydroprojects addressed in the following material have large non-game fish populations and fluctuate. Both problems need attention.

We would like the Power Planning Council to direct the operating agencies to (1) initiate studies to find ways of controlling non-game fish populations and implement, and (2) encourage operating agencies to review reservoir operations toward minimizing water level fluctuations.

SNAKE RIVER BASIN

Basin Description

Geography

The Snake River enters the Columbia River at RM 324 and forms Oregon's eastern boundary for 216 miles.

Major tributaries, within Oregon are: Grande Ronde, Imnaha, Burnt, Powder, Malheur, and Owyhee rivers.

Three hydroprojects fronting Oregon, on the Middle Snake, are addressed in this write-up: Hells Canyon Dam at RM 247, Oxbow Dam at RM 273, and Brownlee Dam at RM 285.

Hydrology

The Snake drains 109,000 square miles and contributes about 20% of the volume of the Columbia River.

Annual precipitation ranges from 6 to 70 inches and much of it falls as snow. More than 50% occurs during the period November through March. Streams, for the most part, are shy on natural streamflow.

There are several irrigation impoundments in the basin.

Recreation

Recreation is an increasingly important industry. Many thousands of participants come from a wide area to use the natural resources: mountainous terrain, forested areas, numerous bodies of water, and an abundance of fish and wildlife.

Resident Fish Resources

Rainbow trout are the most important trout species in the basin and kokanee have been stocked into Hells Canyon Reservoir.

Channel catfish, crappie, and smallmouth bass provide excellent fisheries. White sturgeon numbers have declined.

Several reservoirs have provided biological conditions more suitable to the production of nongame fish than game fish.

Hells Canyon Dam Project

Project Description

Hells Canyon Dam and Reservoir is an Idaho Power Company project at RM 247 on the Snake River. It was completed in 1968.

The reservoir is about 2,400 acres in size and 23 miles long.

History of Fish

Excellent crappie and smallmouth bass populations exist in Hells Canyon Reservoir. Some natural rainbow production is coming from tributary streams. Kokanee stocking began in 1980.

Impacts on Fish

Hells Canyon Dam cut off anadromous production above RM 247, and white sturgeon numbers have declined. The standing water environment has benefited warmwater fish species populations. Nongame fish populations have exploded.

Management Goals and Objectives

We will manage Hells Canyon Reservoir for warmwater populations: smallmouth bass, crappie, and channel catfish. We are also anticipating some level of kokanee production, and they will be stocked annually.

Recommendations to Protect, Mitigate, and Enhance Fishery Resources

1.8 The rough fish population should be controlled and/or used. It may be possible to profitably execute a commercial fishery on the carp.

OxBow Dam Project

Project Description

Oxbow Dam and Reservoir is an Idaho Power project at RM 273 on the Snake River. It was completed in 1961.

The reservoir is about 1,145 acres in size and 13 miles long.

History of Fish

For several years after impounding, Idaho Power released yearling rainbow trout. This Department is presently releasing fingerling trout.

Warmwater game fish populations have thrived with the impounded water and have been able to compete with the large nongame fish population.

Impacts on Fish

The standing water environment has benefited warmwater populations. Nongame fish populations have exploded.

Management Goals and Objectives

We will manage Oxbow Reservoir for warmwater populations. Annual fingerling trout releases are contributing to the fishery, but the amount is unknown.

Recommendations to Protect, Mitigate, and Enhance Fishery Resources

1.8 The rough fish population should be controlled and/or used. It may be possible to profitably execute a commercial fishery on the carp.

Brownlee Dam Project

Project Description

Brownlee Dam and Reservoir is an Idaho Power Company project at RM 285 on the Snake River. It was completed in 1959.

The reservoir is about 15,000 acres in size and 55 miles long.

History of Fish

For some time after impounding, Idaho Power released yearling rainbow trout into Brownlee Reservoir.

Excellent populations of crappie, smallmouth bass, and channel catfish are present.

Large populations of nongame fish species exist.

Impacts on Fish

The standing water environment has benefited warmwater populations and they have been able to compete with the large populations of nongame fish.

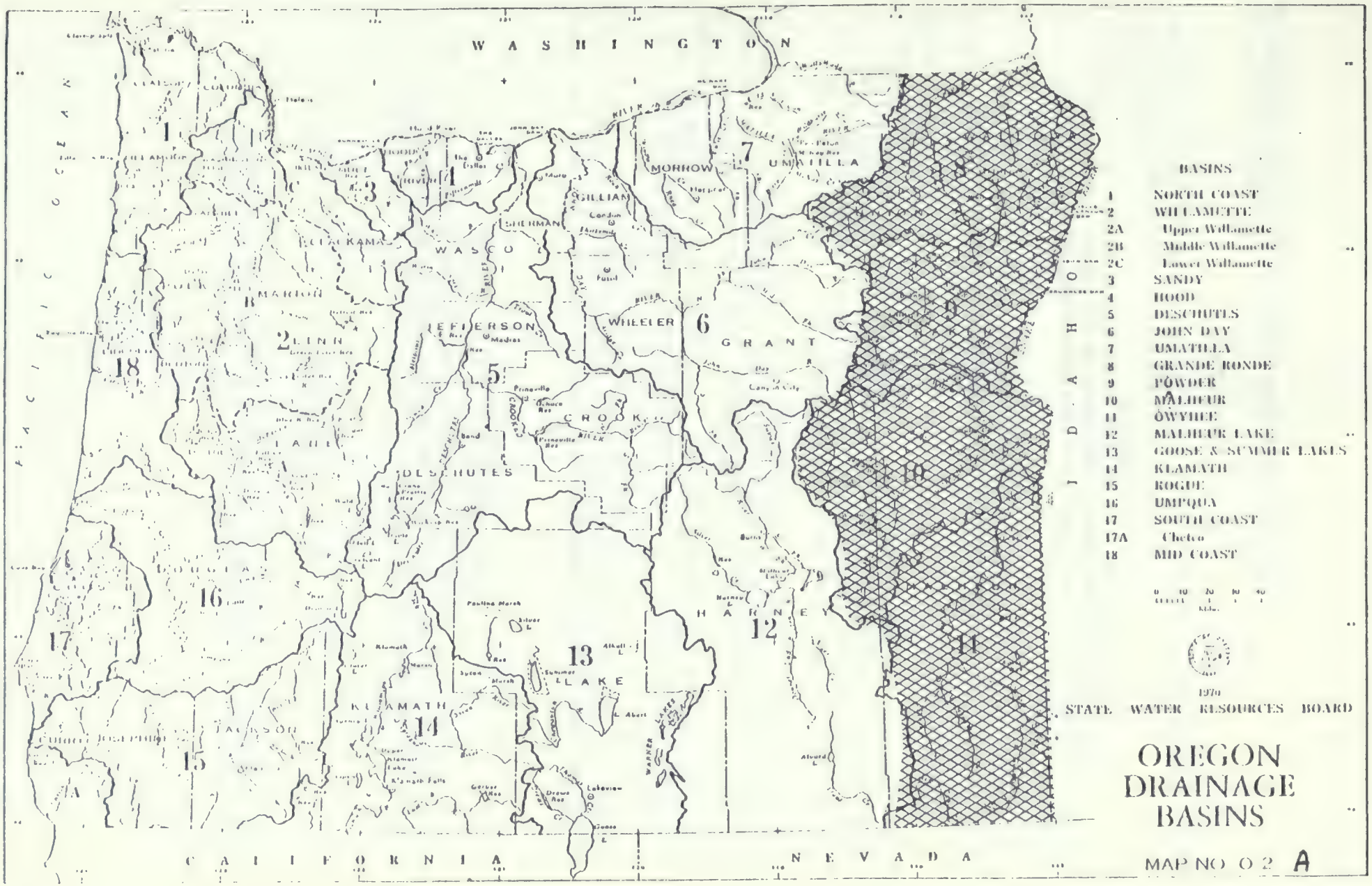
White sturgeon numbers have declined as well as rainbow trout.

Management Goals and Objectives

We will manage Brownlee Reservoir for warmwater populations.

Recommendations to Protect, Mitigate, and Enhance Fishery Resources

1.8 The rough fish populations should be controlled and/or used. It may be possible to profitably execute a commercial fishery on the carp.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COLUMBIA RIVER MAIN STEM

Basin Description

Geography

The Columbia River flows westward a distance of 309 miles, forming the boundary between Oregon and Washington, and discharges into the Pacific Ocean near Astoria.

Four hydroprojects, extending upstream from Bonneville to the confluence of the Columbia and Snake rivers, will be addressed in this write-up:

Bonneville Dam	- first on the river	- at RM 145.5	- operational 1938
McNary Dam	- second on the river	- at RM 292	- operational 1953
The Dalles Dam	- third on the river	- at RM 192.4	- operational 1957
John Day Dam	- fourth on the river	- at RM 216	- operational 1963

Hydrology

The Dalles gauging station measures the runoff from a drainage area of about 237,000 square miles. Annual discharge has averaged 140,800,000 acre feet per year.

The construction of over 50 large and small reservoirs throughout the basin has regulated the river flow.

Recreation

Tens of thousands of tourists, vacationers, campers, boaters, hikers, swimmers, water skiers, fishermen, and hunters use the main stem and impoundments throughout the year.

Resident Fish Resources

Warmwater game fish species are the most important residents in the main stem Columbia. Rainbow, cutthroat, and bull trout are also present as well as some percentage of anadromous smolts that do not migrate.

Bonneville, McNary, The Dalles, and John Day Projects

Project Description

The four Corps of Engineers projects date back to 1938 (Bonneville) and impound water from RM 146 to RM 351.

Fish passage facilities are incorporated into all the projects.

History of Fish

At least 30 species of fish are present in the main stem Columbia.

Excellent populations of smallmouth bass exist, and the walleye population is expanding.

Impacts on Fish

Stream habitat has been eliminated in 205 miles, but additional acreage of impounded water has benefited the warmwater game fish populations. The large nongame fish populations generally have an adverse impact on the more desirable species.

Management Goals and Objectives

Management programs will be oriented toward warmwater game fish populations.

Recommendations to Protect, Mitigate, and Enhance Fishery Resources

1.2 Investigate the reservoir operations; determine and document the impact of pool fluctuations on warmwater game fish populations.

1.8 The rough fish population needs to be controlled and/or used. We recommend initiating such a study.

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DESCHUTES RIVER BASIN

Basin Description

Geography

The Deschutes River basin is located in the north central part of Oregon; bounded on the west by the Cascades, lava plateaus on the south, the Ochoco Mountains and plateau between the Deschutes and John Day on the east, and the Columbia on the north.

Major tributaries are the Little Deschutes, Crooked River, Metolius River, Warm Springs River, and White River.

Two hydroproject dams are located on the Deschutes River. Pelton Dam is at RM 100 and Round Butte Dam at RM 107.

Hydrology

The Deschutes system drains about 10,400 square miles (11% of the state).

There are major seasonal and geographical pattern differences in the water yield distribution--eastside tributaries very low in comparison to westside tributaries. Most of the stream system is characterized by low flows in the late summer, fall, and winter and high flows in the spring and early summer under natural conditions.

There are several irrigation impoundments in the basin.

Recreation

Recreation is very important to the economy of the basin. The Deschutes system has a nationwide reputation for excellent trout and steelhead fishing. The lower 100 miles of the Deschutes is a premier angling stream managed for wild trout with very restrictive angling regulations.

The Crooked River, below Prineville Reservoir, is an extremely productive stream; and the Metolius River is managed with hatchery trout.

Crane Prairie, Prineville, and Wickiup reservoirs provide good rainbow trout fisheries, as well as East, Paulina, Davis, and Big Lava lakes. Suttle and Billy Chinook lakes contain excellent kokanee populations.

Resident Fish Resources

Rainbow trout are the most important trout species in the basin. Brook trout are stocked in many waters and kokanee are present in a few. Whitefish are common throughout the system. Several species of warmwater fish are also present.

Pelton-Round Butte Projects

Project Description

The Pelton-Round Butte complex consists of (looking upstream) Pelton regulating reservoir, Pelton Dam (Lake Simtustus), and Round Butte Dam (Lake Billy Chinook). The projects are owned and operated by Portland General Electric Company; at RM 100 and 107, respectively, on the Deschutes River. Pelton Dam was completed in 1957; Round Butte in 1963.

Upstream and downstream fish passage facilities were incorporated into the projects, but after several years of evaluation a hatchery was built to provide anadromous production.

Lake Simtustus covers 600 acres maximum and fronts on the Warm Springs Indian Reservation. There is a normal 5-foot daily fluctuation. Maximum acreage of Billy Chinook is about 4,000 with a maximum depth of 415 feet. Crooked River and the Metolius both enter the Deschutes in Lake Billy Chinook.

History of Fish

Lake Billy Chinook now supports the largest kokanee population in the state. Management began with rainbow trout, but they were killed by Ceratomyxa. The kokanee population is naturally reproducing. Kokanee and rainbow are stocked in Lake Simtustus.

Impacts on Fish

The hydroprojects cut off all anadromous production above RM 100. Wild Deschutes rainbow trout used the stream habitat prior to impounding and the projects may have severed the migration pattern of the bull trout population into the Metolius River. Competition from rough fish is a major problem. About 92% of the inventory-netted fish in the reservoirs are rough fish.

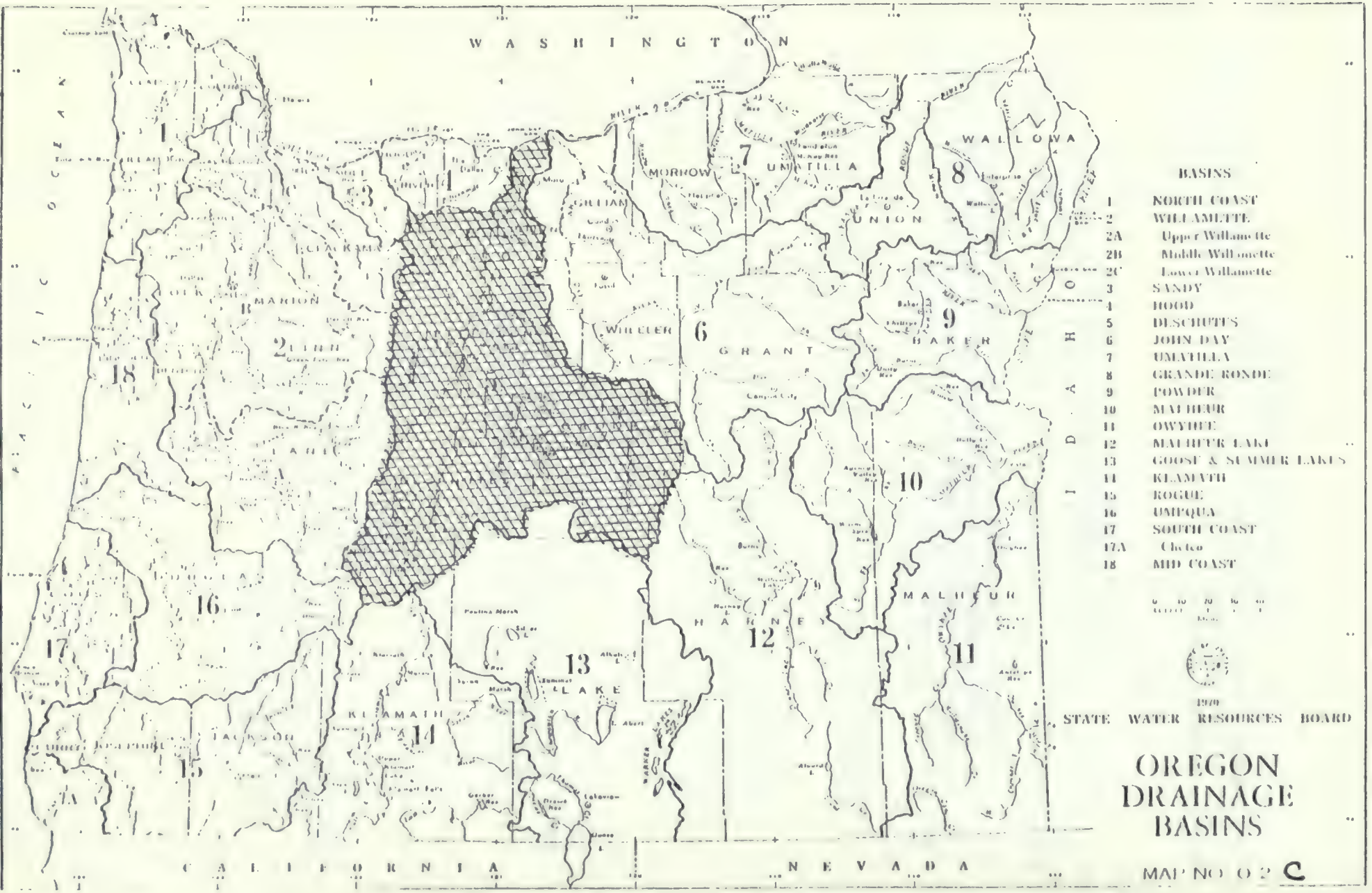
Management Goals and Objectives

We will manage both reservoirs for trout. The kokanee population in Lake Billy Chinook is selfperpetuating, but kokanee and rainbow will be stocked annually in Lake Simtustus.

Recommendations to Protect, Mitigate, and Enhance Fishery Resources

1.8 Rough fish control and/or use is the number one problem in the complex.

Suckers and squawfish were present prior to the impoundments, but the slack water provided excellent habitat for them and they now make up 90+% of the population. We have tried purse seining and it was not effective.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WILLAMETTE RIVER BASIN

Basin Description

Geography

The Willamette basin is roughly rectangular with a north-south dimension of about 150 miles and an average width of 75 miles. It is bounded on the east by the Cascade Range, on the south by the Calapooya Mountains, and on the west by the Coast Range. The Columbia River from Bonneville Dam to St. Helens forms a northern boundary. The basin encompasses the major population centers of Oregon and about 12% of the total area of the state. Elevations range from 10 feet to over 10,000 feet.

Major tributaries include the Clackamas, Santiam, and McKenzie rivers as well as the Coast Fork and Middle Willamette rivers.

Seven major hydroprojects are located in the basin: Detroit-Big Cliff, Green Peter-Foster on the Santiam; Cougar, Leaburg-Walterville (addressed in the anadromous fish section) on the McKenzie; Hills Creek, Lookout Point-Dexter on the Middle Fork Willamette; and North Fork, Faraday, River Mill, and Timothy on the Clackamas.

Hydrology

The Willamette basin encompasses about 11,000 square miles.

The total surface water yield of over 27 million acre feet is more than enough to satisfy needs, but geographical and maldistribution results in water shortages in some areas at times when demand is greatest. Many streams are overappropriated. Only about 7% of the annual water yield occurs during the summer months of June through October.

In the early 1930's the Corps of Engineers prepared a plan, known as the Willamette Basin project. In 1938 and by subsequent acts, Congress authorized the Corps to construct 17 reservoir projects--14 multipurpose storage projects and 3 regulating projects.

The Willamette projects (containing about 1,702,000 acre feet of multiple-use storage) are coordinated with the rest of the Columbia basin and with other concerned agencies. All projects operate as a system, with regulation varying according to season. Seasonal regulation of each reservoir is guided by a flood control rule curve.

Recreation Use

Tourism is the state's third largest industry. Outstanding recreation facilities in the basin, many water related, have caused sharp increase in sightseeing, water sports (boating, swimming, and water skiing), picnicking, hiking, fishing, and hunting. About 59% of the basin is privately owned and 38% federally owned, of which 34% is Forest Service.

Water from the streams of the basin are of suitable quality for most uses.

Data from past angler surveys show about 810,000 angler days for trout and 111,000 angler days for warmwater species.

The basin supports major runs of anadromous fish.

Resident Fish Resources

Rainbow and cutthroat are native to the basin and provide a major contribution to the stream trout fishery. Rainbow are the primary species stocked into lowland lakes and reservoirs.

Good populations of whitefish are found throughout the basin.

Warmwater game fish are not native but the brown bullhead, channel catfish, largemouth bass, crappie, and bluegill have been introduced and are of increasing importance.

Timothy Dam Project

Project Description

Timothy Dam and Reservoir is a Portland General Electric Company project at RM 16 on the Oak Grove Fork Clackamas River. The project was completed in 1955. Power is not generated at Timothy Dam.

The reservoir covers 1,430 acres at full pool and 410 acres at minimum pool with a drawdown of 55 feet.

History of Fish

Fingerling rainbow, brook trout, kokanee, and cutthroat have been stocked in Timothy Reservoir. Kokanee and brook trout are now selfsustaining. Cutthroat returns were poor and stocking was discontinued but rainbow continue to be stocked annually.

Impacts on Fish

Some wild cutthroat stream habitat was lost when the project was developed. Fingerling trout have been stocked annually; but the drawdown, more severe in recent years, is curtailing the population. It may be necessary to stock yearling trout.

Management Goals and Objectives

We will continue to manage Timothy for trout but it may be necessary to start stocking yearling hatchery rainbow. Kokanee are small and abundant but do not command a major fishery. Returns from fingerling rainbow have been poor the past few years.

Recommendations to Protect, Mitigate, and Enhance Fishery Resources

1.7 Many acres are exposed in the drawdown area that need to be vegetatively covered for food production. The cost will probably be $1,500 to $2,000/acre.

1.8 The fingerling trout program is presently not doing a good job, and it may be necessary to start releasing yearling-sized fish. This change will probably cost an additional $40,000.

Detroit Dam Project

Project Description

Detroit Dam and Reservoir is a Corps of Engineers project at RM 48.5 on the North Santiam River. It was completed in 1953.

The reservoir is 3,850 acres maximum, 1,450 acres minimum, with an annual drawdown of 140 feet.

History of Fish

Fingerling rainbow and kokanee, and yearling rainbow, have been stocked since impounding. Kokanee were self-sustaining until the 1964 flood; we began stocking them again in 1979.

Angler use at Detroit Reservoir is very heavy.

Impacts on Fish

The Detroit-Big Cliff complex terminated anadromous fish runs. Mitigation is provided in Corps-funded hatcheries.

Management Goals and Objectives

Detroit Reservoir is managed for a trout fishery. Annual releases of fingerling and yearling rainbow are providing a satisfactory fishery. We would like to establish a kokanee population.

Recommendations to Protect, Mitigate, and Enhance Fishery Resources

1.7 Many acres are exposed in the drawdown area that need to be vegetatively covered for food production. Costs will be $1,500 to $2,000/acre.

Foster Dam Project

Project Description

Foster Dam and Reservoir is a Corps of Engineers project at RM 38.5 on the South Santiam River. It was completed in 1967 and is a regulating reservoir for Green Peter, on the Middle Fork Santiam River.

The reservoir is 1,260 acres maximum with about 18 miles of shoreline area. Fluctuation and annual drawdown is minimal. Upstream passage facilities are present.

History of Fish

The system above Foster Dam was chemically treated prior to impounding. Fingerling and yearling trout have been stocked annually and steelhead smolts have gone into and above the reservoir.

About 9,500 angler days were spent during the first 10 weeks of trout season in 1980.

Impacts on Fish

The system above Foster Dam was chemically treated prior to impounding and hatchery fish have been released since. Populations of brown bullheads, bass, and bluegills are present.

Although the system was chemically treated, a large population of rough fish (suckers, shiners, and squawfish) are present now.

Management Goals and Objectives

Foster Reservoir will continue to be managed for trout. Steelhead smolts are released in and above the impoundment and do enter the trout fishery in greater numbers than desired. Warmwater populations are small and will probably remain so.

Recommendations to Protect, Mitigate, and Enhance Fishery Resources

1.8 The rough fish populations are competing with the trout and warmwater populations and need to be controlled and/or used. We are not sure how this can be done.

Cougar Dam Project

Project Description

Cougar Dam and Reservoir is a Corps of Engineers project at RM 4.5 on the South Fork McKenzie River. It was completed in 1963. Facilities are present for passing adult and juvenile fish but they failed (see anadromous section).

The reservoir is 1,235 acres maximum, 570 acres minimum, with an annual drawdown of 174 feet.

History of Fish

Hatchery fingerling and yearling rainbow have been stocked since impounding. Wild rainbow and bull trout were present in the affected area.

Impacts on Fish

Drawdown is severe and yearling rainbow are needed in conjunction with fingerling. There are no rough fish in the reservoir.

Management Goals and Objectives

Cougar Reservoir will continue to be managed for a trout fishery. Both fingerling and yearling rainbow are stocked annually. Trout loss was mitigated for. The anadromous section gives high priority to rehabilitating the salmon run.

Recommendations to Protect, Mitigate, and Enhance Fishery Resources

1.7 Many acres are exposed in the drawdown area and need to be vegetatively covered for food production. See anadromous section for rehabilitation proposal.

Dexter-Lookout Point Projects

Project Description

Both projects are Corps of Engineers; Lookout Point at RM 19.9 on the Middle Fork Willamette River and Dexter just below. Dexter is a regulating reservoir for Lookout Point. Both were completed in 1954.

Lookout Point Reservoir is 4,255 maximum, 2,090 acres minimum, with a drawdown of 100 feet. Dexter is 1,075 acres maximum and 960 minimum with about 5 feet of drawdown.

History of Fish

Trout were stocked until 1960 in Lookout and until 1962 in Dexter. Stocking programs were terminated in both because of poor returns. Kokanee were released into Lookout Point beginning in 1981.

Impacts on Fish

Creation of the slack water behind both dams has provided excellent habitat for several species of rough fish (suckers, chiselmouth, shiners, and squawfish), and the reservoir populations are about 90+% rough fish now. Competition with fingerling trout plants did not allow the trout to persist.

Crappie and brown bullheads are present but in limited numbers. Both reservoirs provide poor fishing.

Management Goals and Objectives

We will evaluate kokanee in Lookout Point prior to asking our Commission's approval to stock a hybrid bass. Zooplankton production appears to be sufficient to carry a limited number of kokanee. A management plan has not been finalized for Dexter.

Recommendations to Protect, Mitigate, and Enhance Fishery Resources

1.7 Many acres are exposed in the drawdown area that need to be vegetatively covered for food production.

1.8 The rough fish population must be controlled and/or used to allow a meaningful trout fishery to exist. See anadromous section for rehabilitation proposal.

Hills Creek Dam Project

Project Description

Hills Creek Dam and Reservoir is a Corps of Engineers project at RM 45.5 on the Middle Fork Willamette River. It was completed in 1962.

Maximum reservoir acreage is 2,710, minimum is 1,300, with a drawdown of 127 feet.

History of Fish

The system above the dam was chemically treated prior to impounding. Fingerling rainbow trout have been stocked annually and originally the impoundment was quite productive. Sediment has been, and continues to be, a problem. Crappie were illegally introduced and their population is expanding.

Impacts on Fish

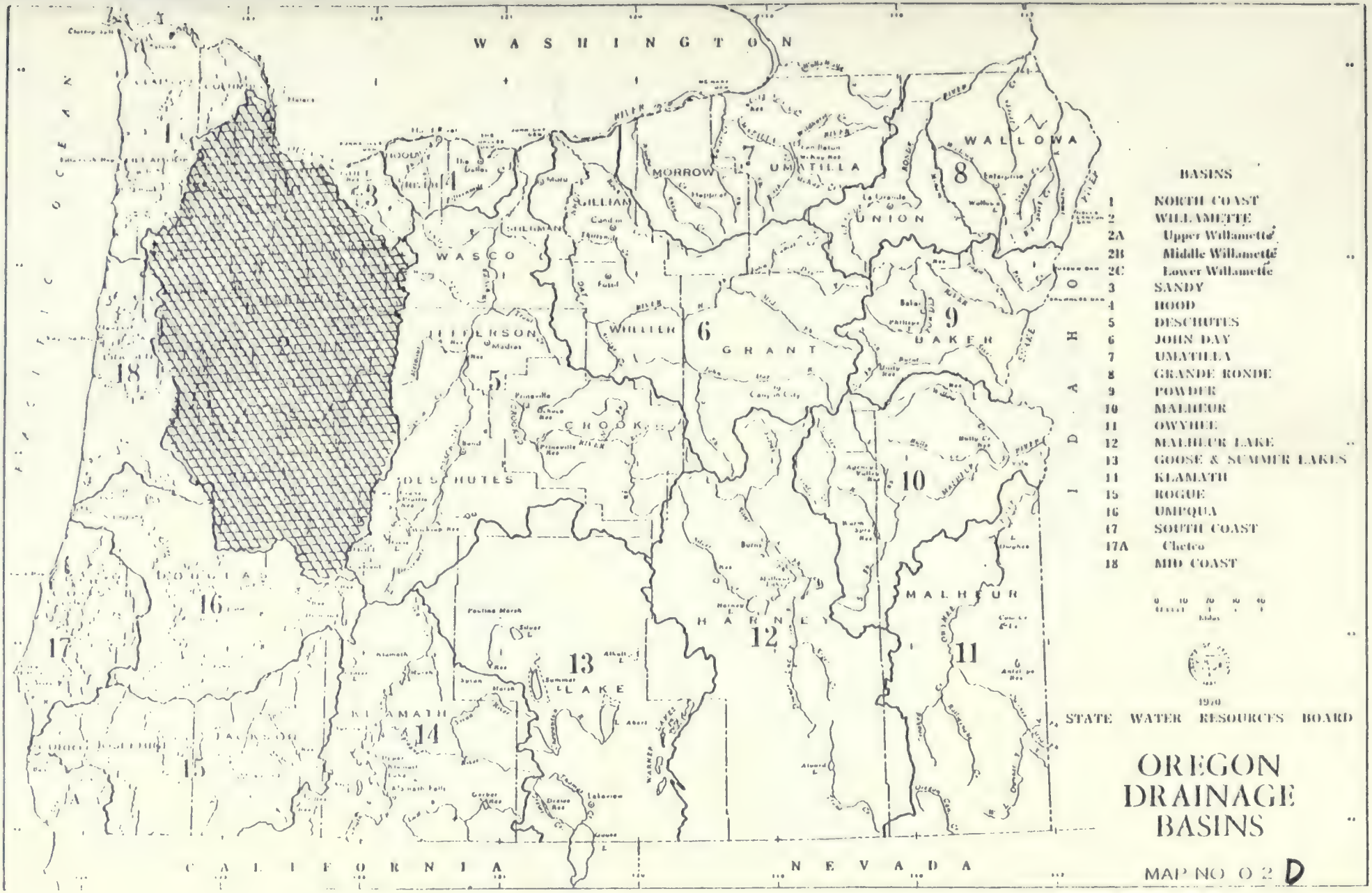
The 127-foot drawdown, and subsequent minimum pool, has curtailed the number of fingerling stocked annually. The raw, exposed acreage in the drawdown area contributes to the sediment problem. As a result of the above problems, fishing in the reservoir is mediocre.

Management Goals and Objectives

We will continue to manage Hills Creek Reservoir for a trout fishery. The crappie were illegally stocked but their population is expanding and more angling pressure is being exerted on them.

Recommendations to Protect, Mitigate, and Enhance Fishery Resources

1.7 The drawdown area needs to be vegetatively covered to provide additional food production and curtail sediment. Costs will probably be $1,500 to $2,000/acre.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2C Lower Willamette
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4 HOOD
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WILDLIFE

RECOMMENDATIONS FOR THE PROTECTION, MITIGATION, AND ENHANCEMENT OF WILDLIFE IN THE COLUMBIA RIVER BASIN

RECOMMENDATIONS FOR THE PROTECTION, MITIGATION AND ENHANCEMENT OF WILDLIFE IN THE COLUMBIA RIVER BASIN

Submitted in accordance with Sec. 4(h)
of the Pacific Northwest Electric
Power Planning and Conservation Act
P. L. 96-501

by the

U. S. Fish and Wildlife Service
Washington Department of Game
Idaho Department of Fish and Game
Oregon Department of Fish and Wildlife

November 1981

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RECOMMENDATIONS FOR THE PROTECTION, MITIGATION AND ENHANCEMENT OF WILDLIFE IN THE COLUMBIA RIVER BASIN

Floodplain environments are highly productive and often essential habitats of principal importance to wildlife. Floodplain and riparian habitats are frequently critical to resident wildlife and to wildlife that depend upon them for survival during certain seasons or portions of their life cycles. Man, too, has centered his development in this fertile and productive zone, and continues to expand his activities in a land type which comprises only about five percent of the nation's land area. One major expanding use of this area is the production of electrical power, an activity which greatly alters the wetland, riparian, and general floodplain areas of river valleys which are of such importance to wildlife.

Hydropower development in the Columbia River Basin has been farreaching, the most obvious example being the mainstem Columbia River. Development to date has centered in northern Oregon and in Washington. About one-half million acres of floodplain and river valley land in Washington have already been inundated.

Development of hydroelectric power has had very serious impacts on many species of wildlife, and only a portion of these impacts have been addressed, studied, and corrected or minimized. While the Fish and Wildlife Coordination Act and other laws and regulations seem to signify legal protection for wildlife and to call for mitigation of impacts, the actual implementation of measures has been notably delayed and inadequate. Early power projects were completed with only token mitigation.

More recently, projects such as Wells, Lower Snake River, and Dworshak demonstrate improvement in the response of development agencies and organizations to wildlife mitigation responsibilities. Despite this improvement, it remains difficult to obtain adequate mitigation for losses. Wildlife mitigation is often relegated to poor sites where opportunity for success is limited. Technology for creating high quality habitat in confined space needs refinement. Periodic evaluation of mitigation success is necessary for improvement of these skills. Another problem is accurate identification of wildlife losses. Studies show that impact assessments are usually very conservative.

This report is hereby submitted to the Northwest Power Planning Council (NPPC) to meet requirements of the Pacific Northwest Power Planning and Conservation Act, P.L. 96-50 (The Act). The Act requires development and adoption of a program to protect, mitigate, and enhance fish and wildlife resources along the Columbia River and its tributaries. The NPPC established under the Act was directed to request from Federal and State fish and wildlife agencies and appropriate Indian Tribes, recommendations for a program to protect, mitigate, and enhance fish and wildlife, as follows:

- Recommend measures to protect, mitigate, and enhance fish and wildlife affected by development and operation of hydroelectric projects on the Columbia River and its tributaries.

- Establish objectives for development and operation of hydroelectric projects designed to protect, mitigate, and enhance fish and wildlife.

- Recommend approaches for management coordination, research, and development that will assist protection and mitigation at and between the region's hydroelectric dams.

Wildlife agencies were given three months to provide their recommendations, following which the NPPC over the span of one year will develop a program based on the recommendations, supporting documents, and public comments thereon.

Recommendations for wildlife, and supporting materials and discussion by Federal and State agencies in this report, were drafted to satisfy the requirements outlined above pursuant to The Act. It should be recognized, however, that the time allowed for this effort was not sufficient to cover this broad subject thoroughly, and a continuing dialogue should be maintained to enhance these recommendations.

The order of presentation of issues, remedial measures, and geographical locations in this report signifies their priority ranking from high to low. The priority arrangement of issues and general remedial actions is most clearly displayed in Appendix I. Recommendations have been developed utilizing the established working relationships among agency representatives on the Columbia Basin Wildlife Technical Committee (CBWTC Appendix 2). State and Federal CBWTC representatives have established priorities of wildlife concerns, geographical areas, and corrective measures which are the basis for these recommendations. It should be clearly understood that the issues, measures, and locations discussed and prioritized in this report should not be viewed as the totality of areas of interest or concern.

The following Goal and Objectives are detailed in the report:

GOAL	Develop and support recommendations to the Northwest Power Planning Council for implementation of a program to protect, mitigate, and enhance habitat and wildlife where affected by electrical power development and operation of power generation and transmission facilities within the Columbia River system.
OBJECTIVE I	Assure that formal wildlife representation in all matters of power system planning, management, and operation is accomplished.
OBJECTIVE II	Identify and prioritize activities of electrical power development and operation that impact habitat and wildlife.
OBJECTIVE III	Recommend (identify) measures and locations to protect, mitigate, and enhance habitat and wildlife impacted by development and operation of the Columbia River Basin power system.
OBJECTIVE IV	Recommend additional investigations needed to document measures to protect, mitigate, or enhance habitat and wildlife impacted by development and operation of the Columbia River Basin power system.

We recognize the need for and value of placing cost figures with some of the priority recommendations we have made. It is, however, very difficult in the time available to apply current estimates to recommendations which are, for the most part, at a more generic level. Appendix III provides a short section on mitigation costs, references on mitigation costs, project cost data, and references on wildlife economic values. Continued acquisition and development of this information, which is necessary for development of the wildlife program, must be carried on throughout program development.

I. WILDLIFE REPRESENTATION IN ELECTRIC POWER DEVELOPMENT

There are many agencies and entities having overlapping administrative and operational responsibilities for water development and associated natural resource management in the Columbia Basin. There are, for example, at least nine multiagency commissions, committees, and work groups presently attempting to sort out and resolve Basin water use problems and priorities. But there is no comprehensive, coordinated water management plan or organization for the Columbia River system under which such work could be accomplished. Existing groups formed to coordinate management of the Columbia River lack authority, expertise, or purpose to cover all functions served by the river.

Anadromous fish management goals have been furthered in recent years through interaction with power interests. The Columbia River Fisheries Technical Committee, Columbia River Fisheries Council, Committee on Fishery Operations, Columbia River Water Management Group, Pacific Northwest Commission, and other organizations functioned to seek a balance of user needs. Wildlife interests have not shared these gains, despite wildlife mandates of involved agencies and despite mutually supportive fish and wildlife goals.

Wildlife has been represented in some committees and to some extent in water project licensing, construction, and operation. Project-by-project actions poorly address long-range regional issues and decisions affecting wildlife, if at all, and declines of wildlife continue from cumulative impacts. Despite claims that legal requirements are being met in protecting wildlife values, impacts are not presently being alleviated. System-wide operational changes such for power peaking is one example of serious, unaddressed impacts.

Because of lack of recognition and lack of an organizational structure associated with power planning, development, and operation, it is difficult to assure adequate wildlife representation in power development processes. The fundamental goal of NPPC is to provide for coordinated power and conservation planning and management. We therefore submit some ideas which can improve a generally ineffective regional planning framework for wildlife where those resources are affected by power development. These are general points rather than detailed, pending establishment of a broad framework for comprehensive management of the Columbia Basin power system.

1.1 In concert with recommendations in the anadromous fish report, we recommend that a formal review process be established wherein Bonneville Power Administration, Corps of Engineers, and Bureau of Reclamation request both fish and wildlife recommendations from appropriate agencies and Indian Tribes in any significant decision processes which could affect either of those resources.

1.2 We support the establishment and funding by power interests of a fish and wildlife team composed of:

a) A Fishery River Management Coordinator and Power Management Analyst who could be housed at the National Marine Fisheries Service, as recommended in the anadromous fish report.

b) A Wildlife Management Coordinator or Wildlife/Resident Fish Coordinator to be housed at the U.S. Fish and Wildlife Service

1.3 We recommend formation of a new organization or expansion of the existing Columbia River Fisheries Council to include wildlife and resident fish. This is necessary to fulfill the requirements of The Act to address all resource areas, and to reduce complexity and isolation of coordinating mechanisms which are established.

1.4 We propose that the Columbia Basin Wildlife Technical Committee, as established by agency Directors, be identified as the appropriate coordination point for NPPC, BPA, and other power interests. This will provide an initial focal point for wildlife program development, and an alternative contact, should separation of fish and wildlife elements in future coordination be desirable.

2.0 Impacts to Wildlife and Habitat Associated with Hydroelectric Development

2.1 Inundation

Inundation is caused by raising a water level from a given elevation to a significantly higher, relatively stable elevation. Inundation is one of the major impacts of the construction of large hydroelectric projects, as well as irrigation, flood control, and pumped storage hydro-projects. The depth of inundation may range from less than 5 feet for an operational change to increase the head on generating units, to approximately 100 feet for construction of typical run-of-the-river large hydroelectric projects, to 200 feet or more for high head and storage projects. Impacts associated with inundation include loss and change of shoreline vegetation, soil erosion, changes in water quality and quantity, and flow alteration. Terrestrial habitat is eliminated in the direct impact area. Additional habitat may be lost from associated land clearing, riprapping, relocation of structures and facilities, rights-of-way, borrow and staging areas, and bank erosion. Impounded water creates a harsher microclimate along the shoreline than exists along a free-flowing stream, resulting in less suitable wildlife habitat during periods of extreme high and low temperature (Oliver, 1974).

2.1.1 Big Game

Inundation causes direct loss of wintering and fawning/calving areas for big game. New reservoirs may disrupt, bisect, or eliminate big game migration routes (USFWS, 1964). Food and cover used year-round by big game are lost. The importance of bottomland riparian habitat to big game is illustrated by the results of preimpoundment big game surveys on proposed reservoir sites. The Oregon State Game Commission (1965) estimated that construction of the High Mountain Sheep Hydroelectric Project on the Snake River would inundate habitat that supported 850 deer and 300 elk during the winter. A preimpoundment study of the Cowlitz Development Area in Washington revealed that land to be inundated by the proposed Mossyrock and Mayfield Dams supported an estimated 1,060 black-tailed deer and 200 elk (Oliver et al, 1966). Brigham (1958), in a preimpoundment study of the Swift Creek and Muddy River hydroelectric projects on the Lewis River in Washington, estimated that at least 150 elk and 370 deer wintered in the proposed 13.2 square mile reservoir areas.

A recent study revealed that the 10-foot pool raise in Chief Joseph Reservoir destroyed important mule deer fawn summering habitat along the original reservoir shoreline. (Fielder et al. 1981).

2.1.2 Upland Birds

Upland birds use riparian habitat for nesting, feeding brood-rearing, resting, and for thermal cover in both winter and summer. Inundation causes direct loss of bottomland habitat critical to the survival of upland birds.

Results of a preimpoundment study on the Wells Dam project area on the Columbia River in Washington illustrate the year-round importance of riparian habitat to upland birds. The riparian segment of the sample area contained 58 percent of the pheasants and 67 percent of the quail in the spring, 97 percent of the pheasants, and 69 percent of the quail in the summer, 60 percent of the pheasants and 95 percent of the quail in the fall, and 88 percent of the pheasants and 91 percent of the quail in the winter (Oliver, 1969). In winter, 99 percent of the surviving chukars were found using riparian habitat on the Wells Project area. Postimpoundment studies estimated a loss of 209,300 game birds, including doves, resulting from loss of habitat due to the project (Oliver, 1972). The Oregon State Game Commission (1965) estimated that 23,000 upland game birds used habitat that would be flooded by the proposed High Mountain Sheep Project on the Snake River. Mossyrock and Mayfield Dams on the Cowlitz River in Washington inundated habitat used by an estimated 3,765 upland game birds (Oliver et al, 1966). Lower Snake River studies estimated 120,800 upland game birds would be lost from inundation of bottomlands by four dams (USACE, 1973).

2.1.3 Terrestrial Mammals

Inundation causes a permanent loss or reduction of habitat and reduces the food supply for terrestrial mammals. Small mammals and rodents that have small home ranges within riparian zones suffer complete loss of habitat. This in turn would impact predatory terrestrial mammals by reducing their food supply. A preimpoundment study of the Lower Granite Dam pool site on the Snake River in Washington revealed that 60-75 percent of the small mammals trapped during the

winter and spring were found in riparian vegetation below the prospective high pool level (Water Research Center, 1974).

Before and after studies of Wells Reservoir in north central Washington found about 1,500 cottontail rabbits were lost when 4,680 acres were inundated (Oliver, 1972). About 8,400 cottontails resided in riparian habitat inundated by four lower Snake River Dams (USACE, 1973).

Small mammal losses resulting from Chief Joseph Pool raise were highly evident. Many yellow-bellied marmot burrows were flooded while the marmots were still hibernating. Numbers of Microtus were seen stranded on emergent vegetation and floating debris. These animals died within 3 minutes of becoming stranded (Fielder et al, 1981).

2.1.4 Waterfowl/Shorebirds

Inundation effects waterfowl primarily by causing direct loss of nests and nesting/brooding areas. Wintering waterfowl may also be adversely impacted when inundation causes a loss of food source or an alteration in food availability. Loss of emergent and submergent aquatic vegetation impacts diving ducks (USFWS, 1979). Shorebirds are affected by inundation of mudflats and shallow water feeding areas.

Hydroelectric reservoir often attract large numbers of migrating waterfowl, but waterfowl inventories indicate that current wintering populations of waterfowl on Columbia River reservoirs are less than under preproject

conditions (USFWS inventory counts). Inventories over the last 25 years indicate that Canada goose numbers have stabilized while mallard numbers are declining.

Gibson and Buss (1972) found that Canada goose production declined drastically in their Snake River study area after construction of Little Goose Dam and the subsequent impoundment of the river. Inundation of nesting islands and increased disturbance by humans was determined to be the cause of the decline.

Fielder et al, 1981, examined impacts to Canada goose nesting on Chief Joseph reservoir following the recent 10-foot pool raise. Comparison of Canada goose nesting before and after inundation found nests reduced from a mean of 42.5 nests to a mean of 29 nests. Egg count decreased from 212.5 to 155. Predation on substitute nest sites was significant.

Prior to inundation of the Columbia and Snake Rivers, Canada goose used 90 islands for nesting on the Columbia River from The Dalles pool through Priest Rapids pool and the Snake River from its mouth to Asotin (Bowhay, 1973). After inundation, only 45 islands were used by geese for nesting. The actual island acreage loss was much greater than 50%. Goose nesting activity was reduced by 67%. Increased band returns after impoundment indicated that adult birds were more vulnerable to hunters the first year after inundation as they searched for new resting areas.

2.1.5 Aquatic Mammals

Inundation destroys existing den sites of aquatic mammals and may create a totally unsuitable environment for those animals. Food sources for animals such as beaver and muskrat that depend upon specific types of shoreline vegetation may be completely eliminated by inundation. Dens may be flooded while helpless young are present.

Four Lower Snake River dams inundated 14,426 acres of habitat. Approximately 280 miles of riverine shoreline habitat was lost. Losses of fur animals to inundation amounted to approximately 60 % of the preimpoundment population of beaver, muskrat, mink, otter, and raccoon. Preimpoundment populations of these species was 33,100; postproject estimated populations were 19,725 (Oliver, 1970).

2.1.6 Raptors/Nongame Birds

Inundation causes permanent loss of nest sites for nongame birds that nest in riparian areas. Perch sites for raptors and other nongame birds are lost. Birds that use riparian vegetation for food will be adversely impacted. Loss of riparian vegetation leads to a decrease in insects and small mammals that depend on that vegetation. This in turn affects birds that feed on insects and small mammals. Thermal cover used by birds is eliminated by inundation. Island nest sites of gulls, terns, and herons are greatly reduced or totally eliminated by flooding.

Riparian habitat is extremely important to populations of nongame birds in many areas. Johnson et al (1977) predict that loss of riparian habitat in lowlands of the Southwest could result in extirpation of 47% of the 166 species of birds that nest there. Ohmart et al (1977) found some bird species to be so specialized to riparian communities along the Colorado River that the species are in danger of becoming extirpated if those riparian communities are eliminated. Riparian study plots in Arizona contained up to 10.6 times the number of migrating birds per hectare found on adjacent nonriparian plots (Stevens et al, 1977).

2.2 Water Level Fluctuation

Water development projects that store water for use during periods of the year when it is not readily available result in reservoirs with artificial water level fluctuations. These seasonal fluctuations prevent the establishment of riparian vegetation below the high water level (Baxter & Claude, 1980). In addition, a plan to supply future base power loads with thermal power and additional or "peak" power loads with hydroelectric power will result in increased frequency and magnitude of daily reservoir fluctuations. Reservoirs along the Columbia and Snake Rivers already display barren "fluctuation zones" (McKern, 1976). The size of these barren zones will be increased by increased fluctuations.

Water level fluctuations also cause habitat loss through erosion of streambanks and islands. Grand Coulee Reservoir was the site of 74 landslides in 1967 and 135 in 1974, an increase in erosion which corresponds to an increase in water level fluctuations due to power peaking (McKern, 1976).

2.2.1 Waterfowl/Shorebirds

Artificial water level fluctuations adversely affect waterfowl by flooding nests and eroding nesting islands (USFWS, 1979). In the mainstem Columbia and Snake Rivers, islands are the preferred nesting habitat of Canada geese and are critical to goose production (McKern, 1976; Gibson and Buss, 1972; USFWS, 1979). Geese that select nest sites during a low water period can have their nests flooded during a subsequent high water period. Extreme low water during nesting and

brooding can expose land bridges leading to islands, increasing susceptibility of waterfowl to mammalian predation at critical times (USFWS, 1979). During one nesting season when the water level was dropped to minimum pool level in McNary Reservoir, land bridges were exposed to a number of nesting islands. Coyotes reached three of the islands, destroying all goose nests and killing four adult geese(McKern, 1976). The barren fluctuation zone along the banks of the reservoir creates an additional hazard at brooding areas. Geese that must cross this zone during low water in order to reach brooding areas are exposed to predation. Ducks are impacted by loss of riparian nesting habitat both on islands and along shorelines (Tabor et al, 1980). Loss of aquatic vegetation in fluctuation zones reduces food for diving ducks (USFWS, 1979) and shorebirds.

2.2.2 Aquatic Mammals

Tabor et al (1980) found that beaver and muskrat tend to avoid areas affected by short-term water fluctuations. Sixty-five percent of the beaver dens and 80-90 percent of the muskrats found in the study area were in subimpoundments and ponds subject to less fluctuation than the main reservoir. Fluctuating water levels result in alternate flooding and exposure of dens, reduction or loss of food sources, reduced habitat for den sites, and increased predation.

Fluctuations during the time that young are present in the den can cause drowning of young during high water or exposure of young to predation during low water. Riparian vegetation used as food by aquatic mammals is decreased by fluctuations. As with waterfowl, aquatic mammals are

exposed to predation when they are forced to cross a barren fluctuation zone to reach food. Although very little data is available on the effects of fluctuation on otter and mink, they are not expected to be as seriously impacted as beaver and muskrat (Tabor et al, 1980). However, since otter and mink are born helpless, a sudden increase in the water level when young are present in the den could cause drowning.

2.2.3 Big Game

Water level fluctuations most seriously affect deer by loss of riparian habitat, erosion of fawning islands, and exposure of land bridges to fawning islands during low water periods. In some reaches of the Columbia River such as Hanford reach and John Day pool, islands are extremely important fawning areas. An increase in mammalian predation on fawns due to exposure of land brudges could have a significant adverse impact on fawn production in those areas (Tabor et al, 1980; USFWS, 1979). Loss of riparian vegetation due to fluctuation will decrease food and cover available for deer.

2.2.4 Raptors/Nongame Birds

Nongame birds which nest or feed on the ground in riparian vegetation will be adversely impacted by fluctuating water levels that reduce riparian vegetation. Those species that nest in trees or shrubs will also be affected by a reduction in suitable nest sites. Cover sued by migrating birds will be reduced. Erosion of islands will reduce habitat for nesting gulls, terns, and herons. The same potential for nest flooding exists for gulls and terns as for

waterfowl. Raptors will be affected by a reduction of suitable trees for perching and by a loss of prey species.

2.2.5 Terrestrial Mammals

Water level fluctuations will affect terrestrial small mammals by reducing the amount of riparian vegetation available for food and cover. Tabor et al (1980) found that rabbits and hares prefer to occupy riparian habitat in areas not greatly affected by fluctuations. Larger predatory mammals will be affected by the reduction in their small mammal food supply.

2.2.6 Upland Birds

Upland birds use riparian habitat for nesting and wintering (Tabor et al, 1980; Oliver 1969). A reduction of riparian habitat due to fluctuations will result in decrease upland bird production and upland bird wintering populations (Oliver, 1972).

2.3 Land and Stream Alterations

Land alteration results in direct loss or degradation of wildlife habitat through removal of vegetation and fertile topsoil, filling or draining of wetlands, replacement of native vegetation with vegetation that is less beneficial to wildlife, urban and industrial development, and introduction of toxic substances into the environment. Land alterations are often associated with hydropower projects. Reservoirs inundate roads, railroads, and urban and industrial facilities which must be relocated; construction requires borrow and staging sites; and reservoir operations cause erosion which often requires riprap. Increased human disturbance is a direct effect of land alteration at least on a temporary and often on a permanent basis. This disturbance is a detriment to many game and nongame species.

At Wells Reservoir in north central Washington, about 37% of reservoir shorelines preclude habitat development because of erosion, riprapping, urban development, and other factors (Oliver, 1972). In addition, highways and railroads were relocated and occupy another 120 acres adjacent to the reservoir (Oliver, 1974).

Stream alteration may be included as part of a hydroelectric project when it is necessary to divert a stream around a construction site, to divert water from a small stream into a larger watercourse where a hydroelectric facility is located, or to increase the volume and velocity of water in a stream in order to build up head for the operation of hydroelectric generators. Stream alteration can be very destructive to wildlife and habitat.

Diverting a stream around an area or into another stream or river results in the destruction of part of the original stream habitat. Water quality will decrease due to sedimentation caused by removal of vegetation. The new channel will not have the riparian vegetation that was found along the banks of the old channel. The riparian habitat along the old section of stream will be lost when the supporting water source is eliminated. In addition, construction of the new channel will eliminate habitat that was used for something else.

Channelization for the purpose of draining a wetland that interferes with construction of hydroelectric facilities results in the loss of habitat that is vitally important to the survival of many wildlife species.

Stream channelization for drainage purposes or to increase the volume and velocity of a stream results in severe erosion of the streambanks, and decreased water quality due to sedimentation. Binns (1978) cites the Salt River in Wyoming as an example of a stream adversely affected by channelization. Bank stability has decreased along the Salt River, the channel is wider, shallower, and less productive. Channelization of the Peabody River in New Hampshire caused erosion (at one point the river is three to four times its original width) and silt deposition downstream (Yearke, 1971). Channelization of the Blackwater River in Mississippi doubled the stream gradient, resulting in increased erosion on the river and its tributaries (Emerson, 1971). Barstow (1971) estimated that new economic losses of fish, wildlife, and related recreation due to a channelization project in the Obion-Forked Deer Basin in Tennessee amounted to $2,235,595.00.

2.3.1 Upland Birds

Land alteration associated with hydroelectric development affects upland birds through a direct loss of habitat. Construction-related alterations and roads through riparian corridors eliminate habitat used by upland birds for nesting, brooding, feeding and thermal cover. Relocation of structures following inundation results in further disturbance and habitat loss. Clearing of native vegetation and replacement with other plant species will impact upland birds such as ruffed grouse and sage grouse that are dependent upon specific native plant communities. Changes in land use which often follow hydroelectric development such as housing/industrial development, monoculture farming, and weed control practices further eliminate habitat for upland birds.

Stream alteration causes loss of nesting, brooding, feeding, resting and wintering habitat used by upland birds.

2.3.2 Terrestrial Mammals

Land and stream alterations cause a loss of riparian and other vegetation used by terrestrial mammals for food and for thermal hiding, resting, denning, and rearing cover.

2.3.3 Big Game

Land alteration causes direct loss of winter, summer, and fawning/calving habitat for big game due to land clearing and construction of roads and facilities. Roads cutting through areas used by big game cause problems related to increased human disturbance and vehicle-caused mortality of animals. Lyon (1979) found that elk in western Montana avoid habitat next to forest roads, especially when the density of tree cover is low. In the Blue Mountains of Washington, deer and elk avoid using meadows that are adjacent to roads (Perry & Overly, 1977). Ward et al (1980) found deer and elk very sensitive to disturbance by humans, either walking on roads or in vehicles, particularly on winter range where visibility was high. A questionnaire directed by western States with elk populations revealed that all of the major elk-producing States have had either a decline or change in distribution of elk due to roads (Sundstrom and Norberg, 1973). Roads that cut across migration routes create a hazard for animals and motorists. Roads through big game winter areas can lead to disturbance of already severely stressed animals. Fences in association with hydroelectric facilities can disrupt migration. Bear and cougar are likely to be similarly affected by roads, as these animals avoid areas used by people.

Stream alteration causes a loss of wintering, fawning, calving, and rearing areas. Migration routes can be disrupted by rerouting a stream.

2.3.4 Waterfowl/Shorebirds

The biggest threat to waterfowl and shorebirds from land alteration is the loss of wetlands due to draining and filling. Wetlands are used by waterfowl and shorebirds throughout the Columbia Basin for nesting, brooding, feeding, and resting. Considerable habitat loss due to wetland drainage has already occurred in the Willamette Valley of Oregon and the Lower Columbia Basin (PNWRBC, 1971). Loss of these areas adversely affects both resident birds and migrants by reducing food and cover and forcing animals to go elsewhere to satisfy their habitat needs. Increased human disturbance from urban/industrial developments around wetlands and introduction of toxic chemicals into the wetland environment causes degradation of these areas as wildlife habitat. Alteration of reservoir shorelines can also affect waterfowl and shorebirds. Observations of hydropower reservoirs almost universally find waterfowl feeding and loafing in shallow areas with gently sloping shorelines rather than in riprapped and eroded areas.

Aerial surveys of the Kissimmee River in Florida before and after stream channelization revealed that duck counts declined from 374 ducks/day before channelization to 50/day after channelization (Montalbano et al, 1979). Virtually all of the Kissimmee River floodplain wetland was lost to channelization. That which exists today (22% of the original acreage) was replaced through mitigation.

2.3.5 Aquatic Mammals

Wetland drainage and filling destroys food and den sites used by beaver and muskrat. Drainage that occurs while young animals are in the den exposes them to predation. Clearing of vegetation along streams and construction of roads and buildings in riparian areas destroys habitat used by all aquatic mammals. Water quality degradation caused by toxic chemical introduction and sedimentation due to vegetation removal along streams further impacts aquatic mammals. Increased disturbance by humans in an area decreases suitability of that area as aquatic mammal habitat.

Diversion or channelization of a stream causes permanent loss of denning areas and food sources. The resulting channel may be totally unsuitable as aquatic mammal habitat because of steepness of slope of the banks, decreased water quality, and reduction or loss of food sources.

Beaver, once abundant along the Rio Grande River, have declined drastically due to the diversion of water by channelization and the subsequent loss of riparian vegetation (Schmidly and Ditton, 1978).

2.3.6 Raptors/Nongame Birds

Removal of riparian vegetation results in habitat loss for many migrant and resident nongame birds and raptors. Filling and draining of wetlands destroys habitat used by raptors and nongame

birds for nesting, feeding, brood-rearing, resting, and for thermal and hiding cover. Increased disturbance by humans associated with hydroelectric development drives some species out of the affected area. Introduction of toxic chemicals into the environment has been a cause of reproductive failure and death in birds. Roads add another source of mortality to bird populations from bird-vehicle collisions.

Riprapping of reservoir shorelines is extremely damaging where these alterations replace natural riparian vegetation or even agricultural lands. A comparison of bird use of four different habitat types near the Sacramento River in California (USFWS, 1978) found the following species numbers and bird densities:

Natural riparian vegetation - 90 species: 8,800 birds/ac./yr.

Riprapped riparian areas - 25 species: 620 birds/ac./yr.

Agriculture near natural riparian - 37 species: 12,600 birds/ac./yr.

Agriculture near riprapped areas - 25 species: 580 birds/ac./yr.

Stream alteration causes loss of perch sites and nesting areas. Decreased water quality can reduce or eliminate the food source of some species such as bald eagle, osprey, and kingfisher.

Barclay (1978) found a mean of 31.4 species of birds on unchannelized sites in Oklahoma compared to a mean of 24.4 species on channelized sites. Bird density on unchannelized sites was 1.017 birds/hectare/visit/site, and only 4.9 birds/hectare/visit/site on channelized sites.

2.4 ROW Siting and Management

The Bonneville Power Administration (BPA) indicates that high voltage transmission lines, those with a capacity of 230 kV or greater, will total 19,200 miles and the rights-of-way will occupy about 290,000 acres in 1987 in the Northwest Power Pool area (Oregon, Washington, Idaho, and Montana)(USDE, 1980). In their 1980 EIS, BPA recognizes the following impacts of transmission lines: air quality impacts, microclimate alteration, accelerated erosion, increased sedimentation, vegetation alteration, elimination or modification of wildlife habitat, bird collisions with transmission lines, increased noise, biological effects related to the electrical and magnetic fields surrounding the transmission lines, damage to nontarget vegetation from herbicides and visual impacts resulting from the use of herbicides.

Air quality impacts are expected to result from burning of construction debris, vehicle emissions, and creation of dust during construction of transmission facilities. These impacts would be most severe during the actual construction phase. Microclimatic alteration occurs when vegetation is removed from the transmission line right-of-way (ROW). Impacts of microclimatic alteration include increased snow depth due to drifting, with the result that forage is buried and travel of animals is impeded; increased wind velocity in the unvegetated area, causing animals to avoid that are during cold temperature periods; and increased ground temperature during the summer, causing animals to avoid the unvegetated area during high temperature periods (Thompson, 1977). Sedimentation

can occur where access roads cross streams, and where soil from construction areas is carried into streams. Vegetation alteration occurs when timber and woody vegetation are removed from the ROW for construction and maintenance. Vegetation control is an ongoing activity of transmission rights-of-way involving periodic removal of vegetation thought to cause a threat to transmission facilities. Elimination or modification of wildlife habitat is an effect of vegetation alteration as plants provide most of the cover, and either directly or indirectly supply food to all animals. Bird collisions with transmission lines have been documented for waterfowl, ring-necked pheasant, sage grouse, and sandhill crane (Anderson, 1978; Cornwell and Hockbaum, 1971; Harrison, 1963; Krapu, 1974) as well as other species. Increased noise from the "hum" associated with high-voltage lines has not been proven conclusively to cause avoidance of an area by big game, but may affect smaller animals (Thompson, 1977). The possible biological effects related to electrical and magnetic fields surrounding transmission lines is not well understood and needs further study (Thompson, 1977). The use of herbicides to control vegetation on rights-of-way has been a source of conflict between utility companies and wildlife biologists for some time (Egler, 1953 and 1957; Thompson, 1977). Broadcast or blanket herbicide spraying is the easiest and cheapest method and creates an abrupt edge between the ROW and the adjacent vegetation by destroying all broad-leafed forbs, shrubs, and trees within the ROW. It is sometimes claimed that this creation of edge is beneficial to wildlife and increases animal species diversity, numbers, and abundance in the ROW. This claim is based upon the premise that the growth of seral shrubs and forbs in a forest opening will encourage the immigration of animals dependent upon seral vegetation--

species that could not live in a closed-canopy forest. The actual advantage to wildlife gained by clearing a ROW depends upon the ability of the area to revegetate, the usefulness to wildlife of the plant species that become established in the ROW, the availability of cover adjacent to the ROW, and the quality of the surrounding habitat (Thompson, 1977). In a moist, forested climate such as that found on the west side of the Cascades, a cleared ROW may quickly revegetate with shrubs. In the arid portions of Washington, Oregon, and Idaho, this is not the case. Also, in dryer areas, vegetation of a size and quantity to provide adequate cover for wildlife is often in short supply, and additional losses are undesirable. The extremely large length-to-width ratio of a ROW corridor limits the diversity of the edge created and also limits the diversity of animals found in the ROW. Because ROW corridors are so narrow, the plant species that pioneer in them are often the same species found in the understory of the adjacent forest. The result if that the animal species already found in the forest understory are the ones most likely to be found in the ROW (Thompson, 1977).

An additional impact on wildlife from ROW construction is the construction of access roads and subsequent increase in public use of an area. Disturbance of animals by humans as a result of access roads has been cited as a detriment to wildlife by many authors (Lyon, 1979; Sundstrom and Norberg, 1973).

Rights-of-way through roadless areas may adversely affect animals such as cougar wolverine, spotted owl, and marten, that require large tracts of undisturbed forest.

2.4.1 Big Game

Location of rights-of-way through winter range or fawning areas or across migration routes can adversely affect big game. Growth of browse as a result of clearing a ROW corridor may be beneficial on a winter range but not on a summer range where forage is not limiting and cover is important for protection from the sun. Usefulness of forage created by clearing a ROW in a forest depends upon the plant species that become established, the amount of cover available, the willingness of an animal to venture into the opening created by the ROW, the method and frequency of vegetation control practices by the utility, and the accessibility of the area to big game.

Unrestricted access roads will often mean increased hunter pressure. The extensive line-of-sight created by a cleared ROW corridor may make big game more susceptible to hunter kill or restrict big game movement. Logging and associated road construction in Montana have necessitated more restrictive elk hunting regulations (Thompson, 1977). ROW access roads could cause similar problems. Rights-of-way that bisect migration routes could impact big game if animals were reluctant to cross the opening.

2.4.2 Upland Birds

The main threat to upland birds from ROW location and management, is from loss of riparian cover, which has been shown to be important to upland game at all life stages (Oliver, 1969). The change in microclimate due to vegetation removal could have severe

adverse effects during periods of high or low temperature. Construction during the nesting period can result in destruction or abandonment of nests. Bird collisions with transmission lines have occurred with some species including ring-necked pheasant (Krapu, 1974) and sage grouse (Borell, 1939).

2.4.3 Terrestrial Mammals

Some "wilderness" mammals which are restricted for the most part to roadless areas, could suffer from construction of rights-of-way and access roads through their habitat (Thompson, 1977). Immigration of grassland small mammals into a newly created ROW through a forest, will not happen unless there is a grassland nearby to serve as a source of those mammals (Thompson, 1977). Access roads increase the potential for harassment of terrestrial animals. Removal of vegetation and fallen logs can eliminate denning and rearing habitat for some species.

2.4.4 Waterfowl

Anderson (1978) determined that 200-400 waterfowl (0.2-0.4% of the maximum number present) were killed each fall from 1973-1979 by colliding with high voltage transmission lines that crossed a 32 ha. pond in Illinois. Cornwell and Hochbaum (1971) and Harrison (1973) also report incidences of waterfowl mortality due to collision with high voltage power lines. Decreased water quality in a stream due

to sedimentation that is a result of ROW clearing can degrade nesting/brooding habitat for species such as harlequin ducks and hooded mergansers.

2.4.5 Aquatic Mammals

The main threat to aquatic mammals from ROW construction is a decrease in water quality due to sedimentation or the introduction of herbicides into the aquatic environment. Sedimentation in a stream can occur when ROW vegetation is cleared or an access road is built across a stream (Day and Carvell, 1978).

2.4.6 Nongame Birds/Raptors

A preliminary investigation of rights-of-way in Montana has indicated little if any increase in number or abundance of birds in a ROW compared to the adjacent forest (Thompson, 1977). ROW corridors in an eastern deciduous forest had a lower bird species diversity than the undisturbed forest (Anderson et al, 1977). Some forest birds, such as the spotted owl, require large unbroken tracts of forest (Newton, 1981) and may be eliminated from areas where forests are broken up by rights-of-way and access roads. Raptors on transmission poles are vulnerable to illegal shooting (Ellis et al, 1969). Electrocution of raptors and other birds perched on transmission facilities has been documented (Anderson, 1933; Boeker and Nickerson, 1975; Nelson and Nelson, 1976). Removal of snags during ROW construction is detrimental to cavitynesting birds such as woodpeckers and bluebirds (Thompson, 1977).

3.0 Measures and Locations to Protect, Mitigate, and Enhance Wildlife and Habitat Impacted by Development and Operation of the Columbia River Basin Power System

3.1 Existing Projects/Operational Changes

3.1.1 Measures and Locations - Protection

a. Avoid flooding of important islands, shorelands, and riparian habitats used by wildlife.

The importance of riparian habitat, islands, and shorelands to wildlife has been emphasized by many authors (Oliver, 1974 and 1969; Oliver et al, 1966; Tabor et al, 1980; Stevens et al, 1977; USFWS, 1979; Ohmart et al, 1977; Johnson et al, 1977). Construction of hydroelectric projects usually involves inundation of large acreages of such habitat. For example, the Wells Hydroelectric project on the Columbia inundated 5,542 acres of habitat (Oliver and Barnett, 1966), and the Mayfield and Mossyrock projects on the Cowlitz River in Washington inundated 13,535 acres of habitat (Oliver et al, 1966). In view of the importance of these types of habitat, it is recommended that future operational changes at existing projects, such as pool raises, avoid further loss of riparian and island habitat. Some areas to be protected include, but are not limited to:

John Day pool goose nesting and fawning islands

McNary pool nesting/brooding areas

Bridgeport Bar islands in Wells Pool

Goose pasture at Buckshot Ranch-Priest Rapids

b. Avoid short-term fluctuations which flood islands, shorelands, and riparian habitats used by wildlife during critical or important use periods.

Critical nesting/denning periods for wildlife groups of the Columbia mainstem have been established by Tabor et al, (1980), and are as follows:

> Canada goose nesting: late February through mid-June. Duck nesting: mid-March through mid-June. Colonial birds nesting: early March through August. Beaver and muskrat denning: February to mid-September.

c. Establish general minimum and maximum water levels during key use periods by wildlife.

Fielder (1978) has determined monthly maximum fluctuation and maximum and minimum river elevation tolerable for wildlife activities in each reach of the Columbia and Snake Rivers. This measure is recommended for the entire Columbia River watershed.

3.1.2 Measures and Locations - Mitigation

a. Replace riparian vegetation at levels above maximum pool elevation.

This may require cultivation, irrigation, and fertilization. Success with this mitigation technique is being experienced along the Snake River where upland game birds, waterfowl, deer, and nongame species are being aided by the planting and irrigation of trees, shrubs, forbs, and grasses (Mudd et al, 1980). Planting and irrigation are necessary to avoid a lapse of 10+ years while natural revegatation occurs. Mudd et al (1980) found that only 99 ha. of the 454 ha. of riparian cover that were inundated by the construction of the four Lower Snake River dams have naturally revegetated. Most of this revegetation has occurred in Ice Harbor and Lower Monumental projects which have been in place 14-18 years.

Replacement of riparian vegetation was conducted on two test plots on the Colorado River (Anderson and Ohmart, 1979). Six months after planting, bird densities had increased by 50% equalling levels found in the most abundant riparian vegetation types. After 11 months, the number of avian species in the planted areas was equal to or greater than the number of species in typical riparian sites.

Creation of live streams by use of pump lifts is another technique showing oromise for replacing riparian vegetation. The Columbia Basin has many intermittent and dry watercourses emptying into reservoirs. Creating seasonal or permanent flows presents many opportunities for fish and wildlife mitigation and enhancement.

Recommended sites for replacement of riparian vegetation are all Columbia River drainage reservoirs. A recommended site for creating a live stream is Alkali Flat Creek, which parallels Little Goose and Lower Monumental Reservoirs. Over 30 miles of live stream could be created at this site.

b. Create subimpoundments not subject to fluctuation to provide new brooding and rearing habitat, secure den sites, and provide aquatic and riparian plant food and cover.

Stabilized water levels during the growing season promote the development of pond weeds, aquatic plants, and wetland vegetation, providing food and cover for wildlife (Bellrose and Low, 1978). Subimpoundments should be created by diking suitable shallow reaches, sloughs, and wetland areas, and controlling water levels. By controlling water levels seasonally, general wetland fertility and emergent and aquatic vegetation production can be increased (Kadlec, 1962; Linde, 1969; Christiansen and Low, 1970). Groen and Schroder (1978) and other authors have found that waterfowl use of certain areas increased due to the creation of subimpoundments. In addition, other wildlife, including aquatic mammals, certain upland birds, raptors/nongame, and certain big game may benefit from subimpoundments (Enyeart, 1973; Wood et al, 1980). Locations are entire Columbia River drainage. Specific site recommendations for subimpoundments (from Tabor et al, 1980) include:

Below Bonneville - Washington shore (RM 123): Sand Island (slough at SW end) (RM 131): Arthus Lake (RM 137-139): Pierce Island (slough in center or island) (RM 142); Ives Island (slough near north shore) (RM 142.7).

Bonneville Pool - Oregon shore (RM 152.1); Oregon shore (RM 166.5); Oregon shore (RM 182.3); Oregon shore (RM 183.2); and Oregon shore (RM 190-191).

The Dalles Pool - Oregon shore (RM 197); Oregon shore (RM 210-212).

John Day Pool - Whitcomb Island slough (RM 265.5-269.2); several small sloughs on Washington shore (RM 273-276); Oregon shore (RM 272-274); Patterson Slough (RM 278-280): one large subimpoundment or several small ones; and Washington shore (RM 290.3).

McNary Pool - Slough on south bank of mouth of Walla Walla River; Slough on north bank of mouth of Walla Walla River; one large or several small subimpoundments at mouth of Burbank Slough (RM 318): several sloughs on east shore (RM 323-324.5): and many possibilities in Yakima River delta area (RM 334.5-335).

Hanford Reach - Wooded Island sloughs (RM 348.5-350); sloughs on east bank (RM 351); sloughs on Island (RM 352); Savage Island slough (RM 356.5-359.5); west bank (RM 362.5): sloughs on west bank (RM 365-367): slough on east bank (RM 367.5-368); slough on east bank (RM 370); slough on west bank (RM 370). Biological desirablity of diking these sloughs should be carefully evaluated because of potential anadromous and resident fish use. Stabilization of the entire Hanford Reach is preferred.

Wells Pool - Park Island slough (RM 537)

Chief Joseph Pool - RM 568.5L and RM 576.4L

Brooding areas for ducks should be created and managed near the sites of existing and constructed nesting areas. The habitat value of wetland areas is limited if they lack open water. Construction of ponds in

suitable areas can increase interspersion and edge between open water areas and vegetation, which may improve habitat conditions for a wide variety of wildlife (USFWS, 1978). Lokemoen (1973), Bue et al, (1952), and Mundinger (1976) have noted a high breeding and brooding use of constructed ponds by mallards, teals, pintails, and coots. Aquatic furbearers and nongame species/raptors would also benefit from pond construction (Oakerman, 1980). All new and existing subimpoundments and ponds should be managed to promote production of desirable aquatic plants eaten by ducks (Tabor et al, 1980). Other useful duck management activities in these areas would include elimination of carp, water level control, fertilization, improvement of water clarity, and establishment of desirable aquatic plants. Several sloughs on the Columbia River have the potential for subimpoundment and pond development, but the feasibility (engineering) and desirability (biological) of development should be carefully evaluated on a site-to-site basis (Tabor et al, 1980). A few potential sites are the sloughs listed above for creation of subimpoundments.

c. Zone or dedicate reservoirs or reaches with high wildlife potential for wildlife management by pool stabilization and intense shoreland management for wildlife in suitable sites. Techniques include bank sculpturing, reef construction, fencing, etc.

National refuges and State wildlife management areas located along the Columbia River reservoirs successfully increased wildlife populations and use via habitat manipulation and limitation of non-wildlife uses. McNary Game Range is one example of such an area (Oliver, 1967). Stabilization of specific reservoirs or reaches with high wildlife potential, and intense management for wildlife could serve in the absence

of systemwide controls or regulation for wildlife. Examples are John Day and/or McNary Pools, Hanford Reach, Wells, Lower Granite, and Hells Canyon/Asotin reach.

Many banks along the Columbia River mainstem currently are not able to support riparian vegetation due to terrain limitations and/or development along the shorelines (Tabor et al, 1980). Grading of disturbed or unproductive shorelines to produce more gradual slopes or terraces may allow riparian and wetland vegetation to become established. Grading of banks should be accomplanied by construction of offshore riprap breakwaters, designed to reduce wave action of maximum pool elevations in order to check erosion and protect developing vegetation.

Wildlife agencies having legal responsibility to protect, maintain, perpetuate, and improve fish and wildlife resources are often victimized by authorized use of public shorelands at hydroelectric project reservoirs. This often occurs on project lands where wildlife mitigation has been accomplished but which have not specifically been designated for wildlife mitigation. Reestablishment of riparian vegetation often precedes conflicting development of shorelines. Wildlife populations build; wildlife agencies immediately assume responsibility to manage and preserve these resources that development agency permitting processes allow to be destroyed. Agencies apparently have little or no recourse.

Some unmitigated, but authorized, uses of public shorelands include:

1. Irrigation pumping plants - Directly occupy riparian habitat; serious secondary impacts include conversion of big game winter range (Columbia and Snake Rivers).

2. Industrial and recreational developments - Directly occupy and destroy riparian habitat, introduce harassment and disturbance factors, pollution, and often dredging and spoil disposal (Columbia and Snake Rivers).

3. Private use facilities - PUD's often permit private use of shorelands, allowing pumping plants, orchards, pastures, boat docks, lawns, garbage, fencing, etc., that exclude wildlife and public use (Mid-Columbia PUD's).

4. Transmission corridors - Sometimes cross wildlife mitigation projects (Crow Butte, McNary WRA, etc.).

Proposed corrective actions include:

1. Requiring mitigation of wildlife impacts through existing permit systems;

2. Disallow wildlife habitat to develop on reservoir shorelands not designated for wildlife; or

3. Designating wildlife as a principal use of public shorelands, requiring conflicting uses to pursue other channels for permission to develop.

Low-lying pastures not extensively used by wildlife can be diked and flooded, producing backwater areas filled via high pool elevations and/or heavy rainfall. These backwater areas would benefit waterfowl, nongame birds, aquatic mammals, and furbearers (Mudd and Merker, 1977). Similar areas can be created by excavating higher unproductive lands, producing shallow backwaters available for colonization by a variety of wildlife and wetland vegetation.

All riparian, wetland, and other areas used by wildlife should be fenced to exclude livestock while allowing passage of wildlife species. No grazing system has been shown to be effective in protecting riparian vegetation (Behnke, 1979). Exclusion of livestock will improve habitat conditions, providing for increased waterfowl and upland game bird nesting densities and success (Duebbert, 1969; Duebbert and Lokeman, 1976; Oetting and Dixon, 1975; Baxter and Wolfe, 1973).

Planting in the fluctuation zone should use species which will survive periodic short-term fluctuations (Tabor et al, 1980). Planting of flood-resistant tree species in the fluctuation zones of reservoirs in Tennessee has been successful in providing additional habitat (Bates et al, 1978). Backwater areas should also be planted with species able to withstand periodic flooding and drying. During extended periods of water level drawdown, exposed banks should be seeded with quickly sprouting native grasses. This technique will help to stabilize banks and provide food for waterfowl, big game, and aquatic mammals. Fish will also benefit when seeded banks are reflooded (USFWS, 1978). To be effective, planting of exposed banks must be combined with a plan for seasonal manipulation of the reservoir pool (USFWS, 1978). Planting of

exposed banks has been successful in creating elk pasture at Lookout Point Reservoir in Oregon (Dan Carleson, Oregon Dept. of Fish & Wildl., pers. comm.).

Recommended sites are all Columbia River drainage reservoirs.

d. Improve wildlife carrying capacity of undisturbed portions of impacted sites by vegetation management; reducing disturbance; supplying food, cover, and water; and eliminating existing land/water management conflicts.

This has been done on the Wells Wildlife Recreation area in Brewster, Washington, which was acquired as mitigtation for Wells Dam. Management practices include planting of food plots, restriction of grazing, and placement of guzzlers and feeders for upland birds. Wells WRA provided 11,059 user-days of recreation (consumptive and nonconsumptive) in 1976 (WDG, 1976).

Wildlife value of overgrazed pastures can be improved by planting various vegetation species to produce food and cover. Adjacent to woody cover, plantings of small food patches (.1 to 1 acre) of mixed cereal grains

and forbs and larger fields of grain or corn can be used to increase food and cover for wildife (Leopold et al, 1939; USDA, 1969; USFWS, 1978). Introducing woody plants of various species into pastures can increase habitat diversity and value to wildlife (USDA, 1969, and Thomas et al, 1979). Where elk are using existing pastures or where it is desirable to attract elk, reseeding large pastures with clover grass and oats can increase their value to elk (Mereszczak, 1978).

Food/cover value of existing woody vegetation can be improved in many ways. Mowing and/or fertilizing shrubs increases sprouting and seed establishment, which increases quantity and quality of browse produced (Taylor and Johnson, 1976; Dasmann et al, 1967).

Creation of small clearings in coniferous forest stands will increase cover/forage edges and plant structure diversity and therefore improve habitat value to wildlife (Thomas et al, 1979). Redisturbances should occur between 7 and 15 years (Brown, 1961; Thomas et al, 1979, 1979; Taylor and Johnson, 1976; Sharp, 1963). Deer and elk should make extensive use of these clearings along with ruffed grouse and other bird species (Thomas et al, 1979; Webb et al, 1977; Lay, 1938; Brewer, 1980). All old growth and broad leaf trees and snags should be retained (Oakerman, 1980).

Recommended locations include all Columbia River drainage reservoirs.

e. Regulate water levels during critical use periods--generally early February to midJune for geese and ducks; April to June for beaver.

Regulation of water level elevation during nest and/or den site selection should encourage animals to nest above maximum water elevation. Maximum water level elevation expected during the nesting/denning period should be reached frequently (at least once every 3-5 days) during daylight hours of the nest/den selection period (Tabor et al, 1980; USFWS, 1978).

Nest and site selection periods on the Columbia mainstem have been identified by Tabor et al (1980):

Canada goose nest site selection: early February to mid-May
Duck nest site selection: early March to mid-June
Beaver den site selection: February through June
Muskrat den site selection: February through June

Nesting and denning periods on the Columbia mainstem are as follows (Tabor et al, 1980):

Canada goose nesting: late February through mid-June
Duck nesting: mid-March through mid-June
Colonial birds, nesting: early March through August
Beaver and muskrat, denning: February to mid-September

In no case should water levels be higher during nesting/denning period that during the nest/den selection period. Fielder (1978) has determined monthly maximum fluctuation, maximum and minimum river elevation tolerable for wildlife activities in each reach of the Columbia and Snake Rivers.

Seasonal manipulation of water levels should be planned to benefit wildlife. USFWS (1978) presents a typical schedule of water level control to benefit wildlife. Individual plans should consider species present, timing of various life cycle stages, and the operational requirements of the specific reservoir (USFWS, 1978).

This mitigation effort should be employed in all Columbia River drainage reservoirs.

f. Create and manage new brooding areas for Canada geese near nesting islands by planting and irrigating portions of the shoreline above maximum pool.

Creation of brooding areas along the Columbia River has been successful in the past in increasing waterfowl populations and providing additional recreational opportunities. Maintenance of brooding pastures at McNary Game Range in Washington has been instrumental in increasing Canada goose production in that area. In 1967, it was estimated that management of nesting and brooding areas at McNary resulted in goose production that was five times greater than prior to filling McNary Pool (Oliver, 1967). This additional goose production provided 394 man-days of recreation worth $1,694.20 annually (1967 figures).

Vegetation at new brooding areas should be near the water at minimum pool. To achieve this, the shoreline should have a steep slope from low pool level to slightly above high pool level (Tabor et al, 1980). All sites should be grazed or mowed. Food plants used by geese should be established in the area. Some recommended sites for new brooding areas (from Tabor et al, 1980) include:

John Day Pool - Washington and Oregon shores (RM 274-251) Washington shore (RM 252-254), Oregon shore (RM 253-258) Oregon shore (RM 279)

Hanford Reach - several sites on east shore (RM 355-366) White Bluffs ferry site on east shore (RM 369-370)

Wells Pool - Washburn Island (RM 567-568)

Specific existing brooding areas that should be modified or managed include:

Bonneville Pool - Government Cove (RM 151.5L)

The Dalles Pool - Deschutes Park (RM 204) and Big Miller Island (RM 203-205.5)

John Day Pool - Crow Butte Park (RM 263) and Whitcomb Island (RM 266-268)

McNary Pool - Curlew Peninsula (RM 319-321), Two Rivers Park (RM 324.5), and Chiawana Park (RM 334)

g. Improve existing island habitats and create new islands for nesting, fawning, denning, brooding, and rearing.

(1) Protect islands from erosion using riprap, pilings, or log rafts. Material should be placed 5-10 m. from the eroding shoreline, with openings 2-3 m. wide at 20-30 m. intervals to allow access by swimming animals (Tabor et al, 1980).

Erosion of existing islands is a serious problem in the Columbia and Snake River mainstems. Tabor et al (1980) found that 98% of goose nests in the Columbia River occurred on islands. Valuable cover can be lost when shorelines erode or are severely undercut and slough into the water (USFWS, 1978). Banks can be stabilized by various techniques, including offshore riprap, gabions, or log rafts. Location of offshore riprap, pilings, or log rafts according to the above scheme should protect islands from erosion by waves, while allowing development of riparian and wetland vegetation and access by wildlife (Tabor et al, 1980).

Some islands identified as needing protection (from Tabor et al, 1980), are located at RM 112, 116, 117. 124, 125, 136, 178, 197, 203, 254, 256, 274, 275, 317, 322, 536, 587.5 in the Columbia River.

(2) Build new islands for nesting, fawning, denning, rearing, and brooding. The best locations are at sites of former islands or near existing or potential brooding areas. Dredge spoil can be used to construct new islands, but soil should be of high enough quality to support vegetation. Dredged material has been used successfully in the past to create wildlife habitat (Hunt, 1979). Constructed islands have proven successful in attracting waterfowl (Linde, 1969). Gosling production at Canyon Ferry Reservoir in Montana has tripled since the construction of nesting islands (Childress and Eng, 1979). Man-made islands are also being used successfully to provide habitat for the endangered Yuma clapper rail at Topcock Marsh in Arizona (USFWS, 1978). Some recommended locations for construction of new goose nesting islands include (from Tabor et al, 1980):

John Day Pool Near Willow Creek (RM 250-254), in Willow Creek backwater (RM 253), near Irrigon (RM 280-284)

McNary Pool - Between Badger and Foundation Islands (RM 318-322) and near mouth of Walla Walla River (RM 314-317)

Chief Joseph Pool - Condon's Ferry (RM 568.5L), China Mines (RM 576.4L), Goose Island (RM 568.5), Nespelem Bar (RM 581.7), and Short's Island (RM 582.7)

Islands to benefit nesting ducks should be constructed in suitable subimpoundments, close to brooding areas. Small (10 feet in diameter or greater above water) earthen islands created by depositing rock foundations and covering with soil (Johnson et al, 1978) have proven to need little maintenance. Johnson et al (1978) have shown these islands to be effective in increasing waterfowl nesting densities and success when placed in large shallow wetlands without dugout ponds. This study found that each constructed island (.002 acre average) produced the same number of ducklings as did 53 acres of upland habitat. Recommended subimpoundments for construction of new duck nesting islands include (from Tabor et al, 1980):

Below Bonneville Dam - all new subimpoundments

Bonneville Pool - Ashes Lake (RM 149); Oregon shore at Wyeth (RM 155); Lindsey Creek Pond on Oregon shore (RM 159); Oregon shore at RM 171.5, 172.3, and 172.5; Washington shore at RM 176; McClure Lake (Oregon shore) at RM 176.5; Chamberlain Lake (Washington shore) at RM 179.5

The Dalles Pool - all new subimpoundments

John Day Pool - Willow Creek backwater (RM 252.5), Whitcomb Island embayments (RM 266-269), McCormack Slough (RM 275), Paterson Slough (RM 280), Irrigon WMA ponds (RM 283-287), and any new subimpoundments.

McNary Pool - Ponds and sloughs at mouth of Walla Walla River (RM 315), Hover subimpoundments (RM 317), Curlew Pond (RM 320), J-Line Pond (RM 320), and any new subimpoundments.

Hanford Reach - all new subimpoundments

Wells Pool - all new subimpoundments

(3) Increase size and height of existing islands. Construction should occur during minimum wildlife use periods, possibly using dredge spoil. Rebuilt portions of islands should be planted with native vegetation. Some islands with sections that need to be rebuilt include (from Tabor et al, 1980):

The Dalles Pool - Little Miller (RM 203)

John Day Pool - Threemile (RM 256), Sand bars downstream from Blalock and Sand Islands (RM 271-273), and Sand Island (RM 274)

Hanford Reach - Island 16 (RM 347.5)

Wells Pool - Bridgeport Bar Islands (RM 536-538)

(4) Remove land bridges to protect fawning, nesting, and denning wildlife from predation. Land bridges are a threat to colonial nesting birds, nesting geese, and fawning deer in several reaches of the Columbia River (Tabor et al, 1980; USFWS, 1979). Some recommended locations for removal of land bridges (from Tabor et al, 1980) are:

John Day Pool - unnamed island near Oregon shore (RM 250), unnamed islands near Washington shore (RM 254), boat basin peninsula (RM 254), boat basin peninsula (RM 255), and upstream end of Longwalk Island (RM 275.5-276.5).

McNary Pool - Hat Rock Islands (RM 299) and Foundation Island (RM 322)

Hanford Reach - Wooded Island (RM 349) and IOOF slough Island (RM 365-367)

Wells Pool - upstream Bridgeport Bar Island (RM 537.5)

h. Manage ROW corridors to produce more desirable wildlife habitat.

Recommendations include.

(1) Eliminate broadcast herbicide spraying. Use selective spraying to produce a "valley effect" as described by Egler

(1953 and 1957). This technique leaves a grassy strip in the center of the ROW low shrubs under the wires. From the wires to the margins of the ROW, all plants can be left which do not become forest trees. An alternate scheme would be to spray half of the ROW each period by treating every other 440-yard block or by treating using the strip method, thereby constantly producing wildlife forage and cover.

(2) Establish cover lanes for big game crossings. This has been done successfully for white-tailed deer in New England (Willey and Marion, 1980).

(3) Establish brush piles for wildlife

(4) Modify towers or poles to prevent raptor electrocution.

(5) Leave vegetation screens to block ROW's from view as described by WDG (1970).

(6) Top trees instead of eliminating them.

(7) Close ROW access roads; avoid continuous maintenance roads (use dead end spur roads). The adverse impacts of human harassment of wildlife due to increased access have been well-documented (Goodwin, 1975; Thompson, 1977; Lyon, 1979; Ward et al, 1980; Lundstrom and Norberg, 1973).

(8) Manage for unevenaged stand of vegetation along corridors to reduce line-of-sight distances ("valley effect" as described in part (1)).

(9) Grow wildlife food crops under transmission lines such as fruit-bearing shrubs and trees (Merker and Hale, 1980).

(10) Use topographic features to maximize vegetation diversity (leave mature trees where wires are higher).

(11) Construct perches and roosts and nest platforms on towers to benefit some species, such as raptors. BPA has installed some wood-and-fiberglass nest platforms on transmission poles for use by raptors (Thompson, 1977).

(12) Install higher capacity transmission lines at existing facilities rather than constructing new ROW's.

These recommendations should be incorporated into all existing and future powerlines.

i. Provide artificial nest structures for geese and den sites for beaver, perches for raptors, and roosts and shelters for upland birds.

Old tires filled with wood chips have been placed on rock islands in Wells Pool and are used by nesting geese. Metal washtubs placed in trees are used by nesting geese in the Okanogan and Methow Valleys.

Nest platforms placed on utility poles are used by osprey on the Okanogan River and elsewhere. A design for an artificial den site for beaver is described in Tabor et al (1980).

Perches for raptors should be provided in appropriate habitats by erecting poles with crossarms, girdling trees to create snags, and equipping existing transmission poles with safe wooden perches (Wood et al, 1980). Roosts and shelters for upland birds can be made by creating brushpiles in upland clearings. Recommended locations for placement of structures are all Columbia River reservoirs.

3.1.3 Measures and Locations - Enhancement

a. Acquire, develop, and manage replacement habitat off-site for development of food, cover, and water needs of impacted species.

Acquisition and management of land primarily for wildlife has been successful in the past, benefitting both the resource and the resource-user. The Skagit Game Range in western Washington was acquired to preserve marshlands from drainage for agricultural purposes, and to produce food for grain-eating ducks that were declining due to changing farming practices. Habitat improvement included planting of grain crops. Oliver (1967) estimated that habitat improvements and marsh preservation on the Skagit Game Range contributed directly to an additional harvest of 7,194 ducks, providing 5,664 man-days of recreation worth $24,209.58.

Evaluation of suitable habitat should be made on a project-by-project basis. Replacement habitat should possess as many of the following qualities as possible:

(1) An area capable of improvement for impacted species, using habitat management techniques.

(2) Located as close to the impact area as possible.

(3) An area containing critical habitat for impacted species.

b. Remove conflicting land/water uses by altering management practices through the use of landowner incentives.

Cattle grazing can have long-term adverse effects on riparian vegetation and should be totally restricted from important riparian habitat (Ames, 1977; Davis, 1977). California land managers have recommended tax incentives to preserve riparian lands for wildlife similar to those authorized by the State to preserve agricultural land (Sands, 1978). The 1981 Oregon Legislature passed a bill giving tax exemptions and credits for landowners who maintain and enhance riparian zones (S.B. 397).

c. Raise and release game farm reared wildlife in suitable habitats acquired for public use purposes.

Game farm releases have been successful in the past in increasing recreational opportunities on limited habitat. In 1979, 552,310 ring-necked pheasants were harvested in the State of Washington (WDG, 1981). Assuming 9% of those birds were game farm reared, then 49,708 game farm pheasants were harvested that year. Using a rate of 1.72 hunter-days/ pheasant (Oliver et al, 1975), game farm pheasants provided 85,498 hunter-days of recreation in Washington in 1979.

3.2 Future Projects

3.2.1 Measures and Locations - Protection

a. Locate temporary and permanent reservoirs away from areas used by big game.

The importance of bottomland habitat to big game, particularly in the winter, has been described previously (Oliver et al, 1966; Brigham, 1958; Oregon State Game Comm., 1965). Specific sites recommended for protection are listed in Section 5.).

b. Avoid inundation of farmlands and/or bottomlands used by waterfowl and other wildlife.

An example is the Hanford Reach in Washington. The proposed Ben Franklin Dam would inundate bottomlands, islands, and farmlands used by 50,000 wintering geese and over 200 nesting pairs of geese (Hanson and Eberhardt, 1971). Wintering duck concentrations, exceeding 300,000 birds, have been recorded in this reach (USFWS inventory counts).

c. Retrofit existing sites when wildlife habitats have already been impacted.

Examples would be adding power facilities to irrigation reservoirs.

d. Avoid critical and important riparian habitats when clearing, riprapping, dredging, disposing of spoils and wastes, constructing diversions, and relocating structures and facilities.

Some sensitive areas recommended for protection are listed in Section 5.

e. Persuade government to provide zoning protection, tax incentives, etc., to preserve wildlife habitat.

Several counties in California have zoned riparian floodplains to protect them from development. The Arizona State Legislature is considering a bill that would provide State protection for riparian lands (McNatt, 1978). California requires floodplain zoning to be a part of a county's General Plan (Sands, 1978). The Glen Elder reservoir in Kansas has successfully used floodplain zoning to protect wildlife food and cover from livestock grazing (USFWS, 1978).

f. Manage critical and important wildlife habitats in ROW's.

Avoid clearing of transmission corridors using broadcast or blanket herbicide spraying. Use selective spraying to produce a "valley" effect as described in Egler (1953 & 1957). Avoid building roads by making use

of existing roads. Close roads to motor vehicle access during critical use periods by wildlife. Recommended sites would be all existing or future ROW's.

g. Develop habitat plans for ROW's and commit ROW's to wildlife production.

Habitat plans could involve management of herbicide spraying and planting of fruit-bearing trees and shrubs as described by Merker and Hale (1980). Fertilization on ROW's has been shown to increase forage production for elk by 80 elk-days on one plot and 410 elk-days on another plot (Taber, 1977).

h. Minimize impacts to wildlife during new project construction and filling.

(1) Plan construction activities during July-November to reduce nesting and wintering impacts.

(2) Locate temporary access roads in areas to be inundated.

(3) Use all suitable excavated material to create islands before reservoir is filled.

(4) Fill reservoirs over a several-year period based on projected demands. Using incremental filling, wildlife habitat inundation can be delayed, including extensive flooding of stream habitat

above the dam. Sport fish production will also benefit from this action (USFWS, 1978).

(5) Avoid clearing of all land before reservoir filling, especially near future shorelines. Submerged and partially inundated trees and shrubs will provide good fish ahbitat and will establish snage, used by many wildlife groups including raptors.

(6) Avoid construction activities within 250 m of active raptor nests or wintering grounds. This distance will minimize disturbance during critical raptor use periods (Stalmaster & Newman, 1978).

(7) Construct subimpoundments before reservoir is filled.

3.2.2 Measures & Locations - Mitigation

a. Replace or improve riparian vegetation as recommended above.

b. Create subimpoundments by diking backwaters and sloughs as recommended above.

c. Improve carrying capacity of undisturbed portions of impacted areas as recommended above.

d. Regulate water levels during critical use periods as described above.

Critical use periods will have to be determined on a regional basis for new projects.

e. Make channel alterations during least critical periods, which will have to be established on a regional basis for new projects.

f. Manage ROW corridors for wildlife as recommended above.

g. Provide artificial nest structures as recommended above.

h. Construct ROW's during July-November period to reduce impacts to nesting and wintering wildlife.

3.2.3 Measures and Locations - Enhancement

a. Acquire, develop, and manage replacement habitat off-site for development of food, cover, and water needs of impacted species as recommended above.

b. Remove conflicting land/water uses by altering existing management practices as recommended above.

c. Raise and release game farm reared wildlife in suitably improved replacement habitats, acquired for public use purposes as recommended above.

4.0 Additional Investigations

This report is based on current knowledge and research of hydropower production impacts on wildlife and habitat. However, there still remain many unknowns on the relationship between power development/production and wildlife. This section outlines additional information needed to develop and implement the program to protect, mitigate, and enhance wildlife resources under the Act.

4.1 Inundation

Inventories of habitat and wildlife and identification of critical and important habitats and resources are prerequisites for making decisions on siting of energy facilities. These studies must be the primary considerations in protecting wildlife resources. The recommendations in this report provide initial identification of valuable subbasins, stream corridors. and specific sites and species where available information exists. Information is still needed on other stream systems which are identified herein as high in wildlife values. Refer to Section 5 of this report.

Baseline habitat and wildlife inventories are needed in areas planned for new power development projects or modification of existing projects. These projects result in inundation of riparian, wetland, and other valuable floodplain habitats and result in attendant losses of wildlife dependent on these habitats. In many instances, inventories are either not accomplished or insufficient to adequately determine effects of projects on wildlife.

Many projects have been completed without consideration of wildlife impacts. In most cases, baseline inventories were absent and impacts not assessed. Investigations are needed to determine wildlife impacts of existing projects and to develop mitigation plans for them.

Where inventories are conducted and impacts assessed, mitigtation is often lacking. Mitigation is often slow or never implemented. Seldom is there an evaluation of the success of mitigation methods and programs associated with these projects. Investigations are needed to evaluate mitigation measures and to develop and test measures to protect, mitigate, and enhance wildlife where inundation occurs.

Wildlife professionals believe another effect of inundation is change in micro- and macroclimate resulting from conversion of flowing streams to reservoirs. This effect, however, is seldom a part of studies of project effects on wildlife and habitat. Investigations are needed to evaluate the extent and significance of micro- and macroclimatic changes associated with projects that inundate habitat.

Recent trends in energy development have resulted in the encouragement of development of "small hydro" projects. This has resulted in a myriad of applications for small hydro projects. State and Federal wildlife agencies are experiencing great difficulty in evaluating the large number of these projects. Although many will not affect large areas of wildlife habitat, the cumulative effect of all projects is significant.

Studies are needed to investigate small hydro sites in the Northwest to determine which sites are least damaging to wildlife, to outline which are in critical or important habitats, and to develop an overall mitigat ion plan for small hydroelectric projects in the States of the Northwest.

4.2 Water Level Fluctuations

Recently, a major inventory of riparian habitats and wildlife has been conducted on mainstem Columbia and Snake Rivers (Corps of Engineers, 1976). Following this inventory a study was conducted by WDG, funded by the U.S. Army Corps of Engineers, on the effects of river regulation for power peaking relative to this inventory. To date, no efforts have been undertaken to develop a mitigation plan and program to protect, mitigate, and enhance habitat and wildlife to compensate the effects of peaking.

Efforts are needed to examine, develop, and evaluate measures to mitigate effects of river regulation for power peaking on wildlife and to develop a mitigation plan for areas where peaking effects have been identified. On tributaries to Columbia and Snake Rivers where peaking is planned, investigations are needed to identify critical and important wildlife habitats, to assess effects of planned peaking on habitat, and to develop mitigation plans.

Many of our recommendations for mitigation/compensation of losses expected as a result of water level fluctuations will require additional study to determine if they are biologically desirable, if they are feasible, and if desirable and feasible, how and where they can best be accomplished. The following studies are needed to accomplish mitigation/compensation of peaking impacts and existing operations, and to evaluate success of these mitigation/compensation efforts:

1. Identify location, creation, and management of subimpoundments.

2. Identify location, creation, and protection of islands.

3. Identify location, creation, and management of goose brooding areas.

4. Identify location, shoreline modification, and management techniques for establishing and maintaining riparian habitat.

Objectives of these studies would be: (1) to determine where and how mitigation/compensation measures should be implemented; (2) to determine how the sites and facilities should be developed, maintained, and managed; and (3) to evaluate the success of these measures of mitigation/compensation for providing habitat and wildlife.

4.3 Land Alteration

The principal means of protecting wildlife and habitat from impacts of land alteration is early identification (inventory) of wildlife and habitat to determine where protection is warranted and where development can occur with mitigation of impacts. Where stream systems, reaches, sites, and other areas are proposed for future development, existing and newly developed information can then be used to make siting decisions between and within project boundaries. Ideally, comprehensive basinwide siting reviews should be made early in the planning process.

For each project site there is inherently more flexibility in choosing locations of appurtenant facilities such as roads, staging and equipment areas, buildings, and other features than in choosing areas to be affected by inundation and water level fluctuation. Thus, there is substantial protective and mitigative potential within sites. Alternate locations of land/stream alterations must be examined with regard to protection, mitigation, and enhancement of wildlife habitat. Permanent dedication of protected areas must be assured.

Present shoreline stabilization techniques and other modifications warrant additional investigation with regard to effects on wildlife. Past use of riprap and other stabilization methods has resulted in hundreds of miles of land-water borders with low or zero access and utility to wildlife. Alternative measures, such as offshore breakwaters with shoreline grading and planting, need to be developed for general implementation or for specific locations where wildlife access to water or use of valuable riparian-water borders is required to maintain populations.

Past mitigation of impacts resulting from land/stream alterations has produced established, useful methods. Some of the more subtle impacts and corrective measures still require investigation. Toxic wastes and chemical contamination are less understood and little studied. Creation or enhancement of wildlife habitat on project lands may fail if toxic materials cause direct mortalities.

4.4 Transmission ROW Corridors

Improved methods of managing the land and vegetation in power-line corridors need to be developed. As mentioned earlier, widespread application of broad spectrum herbicides will usually eliminate all forage and much of the cover produced in a corridor. In the interim between the treatment of an individual section of a corridor, animal populations increase to take advantage of the cover and forage produced. The population suffers when the vegetation in the corridor is removed. Alternative treatment methods that accomplish the intent of corridor management with respect to different ecological conditions and wildlife objectives need to be developed for mutual benefit.

Soil compaction has been shown to occur during the construction of transmission line towers. Methods need to be studied that will lead to techniques that prevent and remedy soil compaction, since soil structure is known to influence vegetation and erosion.

Negative impacts of human activity on wildlife populations have been documented. Studies need to be made that determine the levels of human activity that can be tolerated by affected animal species. Early

resolution of conflicting land uses can lead to mutual goal satisfaction. Before new corridor routes are proposed, studies should be made to identify incompatible habitat types and specific locations so planners can more effectively propose corridor routes.

Many studies have been conducted on wildlife impacts or the corridors themselves, but more studies are needed on a larger scale considering adjacent areas. Habitat diversity is thought to lead to ecological stability and is therefore desirable. Corridors in certain habitats can create diversity which in many cases benefits wildlife. However, studies are needed to document wildlife use of corridors considering adjacent habitat types. Impacts, both positive and negative, need to be determined considering a larger area than the corridor in order to determine the true impacts of the corridor. In many cases, effects from management techniques may be unsuited to interface with adjacent habitat types.

The effects of electromagnetic field or corona effects are not well known. More study is needed to identify and measure the impacts on wildlife.

5.0 Summary and Recommendations

5.1 Introduction

This section summarizes and provides recommendations by wildlife agencies to the Northwest Power Planning Council under the Pacific Northwest Electric Power Planning and Conservation Act. This report is the official coordinated response of Federal and State wildlife agencies in the Columbia Basin, except for Montana, which is drafting a separate set of recommendations. Oregon, Washington, Idaho, and the U.S. Fish and Wildlife Service were directly involved in production of this document.

This effort was coordinated through the Columbia Basin Wildlife Technical Committee (CBWTC). Power interests, including the Corps of Engineers, Bureau of Reclamation, and Mid-Columbia PUD's are represented on CBWTC and provided considerable input to these recommendations.

Representatives of treaty Indian Tribes were invited to participate in this effort but chose instead to review our work and provide comment later.

The Columbia Basin Wildlife Technical Committee has also discussed these recommendations with Columbia Basin Resident Fish Technical Committee (CBRFTC) and Columbia Basin Fishery Technical Committee (CBFTC) (the latter represents anadromous fish). These groups have attempted to resolve conflicts in their recommended programs.

Although these recommendations are the official response of the wildlife agencies, it should be recognized that this was a hurried effort. Because of this, the agencies concentrated their efforts on only the highest priority issues and projects. Completion of a program to protect, mitigate, and enhance wildlife resources associated with power development and production on the Columbia River and its tributaries, as required by the Act, will require considerably more effort. It is imperative this be done with involvement of wildlife professionals of the Federal and State wildlife agencies having appropriate jurisdiction and responsibility.

5.2 Establishment of Priorities

The Columbia Basin Wildlife Technical Committee prioritized all subobjectives and tasks as listed in Goals, Subobjectives, and Tasks for Development of the Section 4(H) Wildlife Program (Appendix I). This extensive effort by CBWTC, involving wildlife agency and power biologists, was made to prioritize wildlife impacts resulting from hydropower construction and operation. It was concluded that the activities most damaging to wildlife and its habitat were inundation, water fluctuation, land and stream alteration; and rights-of-way siting, design and management.

Wildlife species groups are impacted differently by these activities. CBWTC found inundation, for example, probably had greatest impact on big game and upland game. Projects that impound winter range and riparian habitat used by these species, therefore, would command top priority for protection, mitigation, and enhancement.

Water fluctuations impose significant impacts on waterfowl and shorebirds, aquatic mammals, and big game, particularly during breeding seasons. Projects where operational changes portend significant fluctuations also warrant great consideration for protection, mitigation, and enhancement.

Land alterations are particularly significant because they occur in association with, or as a result of, hydroelectric development but are seldom seriously considered in mitigation planning or settlements. Upland birds and terrestrial mammals are most frequently affected because of alteration of shorelines (riparian habitat) or adjacent area. Small hydro developments and associated stream alterations may affect waterfowl, upland birds, and aquatic mammals.

Powerline rights-of-way siting, design, and management have differential impacts on wildlife. In dense forest communities of western Washington and Oregon, creation of edge often benefits wildlife. In eastern Washington, Oregon, and in Idaho, biologists find significant damage to big game and upland birds. Many of these impacts could be averted if biological input into site selection, design, and management of transmission corridors were sought.

The CBWTC also prioritized ways to protect, mitigate, and enhance habitat and wildlife.

Protection of existing habitat and wildlife is the greatest concern and highest priority of wildlife agencies. This simply requires avoiding critical and important habitats.

Mitigation of wildlife and habitat impacts on- or off-project is imperative if they cannot be avoided. CBWTC identified mitigation measures that can be successfully implemented to offset hydroelectric production and transmission impacts. The highest ranged measures are: (1) replacement of riparian vegetation out of reach of reservoir fluctuations; (2) creation of stable subimpoundments where habitat can recover; and (3) stabilization of water fluctuations through specific reaches to permit reestablishment of habitat, or dedication of specific reaches or reservoirs to wildlife management. Some authorized reservoir management activities cause delayed conflict with wildlife and require mitigation. Habitat impacts from siting, design, and management of transmission rights-of-way can be mitigated if CBWTC's 11 measures are recognized (Appendix I).

Summary and recommendations for programs to protect, mitigate, and enhance wildlife and habitat on a regional and Statewide basis have been prepared by Idaho, Oregon, and Washington biologists. High priority projects needing protection, mitigation, and enhancement are listed in Tables 1-3.

Table 1 indicates highest priority wildlife habitats within the region where future hydroelectric development should be avoided. Many of the areas of concern are the riparian bottomlands less than 2,500-3,500 feet elevation. These bottomlands provide important winter range and should be protected from inundation. Table 2 shows priority wildlife habitats where initial inundation or fluctuation impacts should be mitigated. Table 3 shows key wildlife habitats that should be protected from or mitigated for transmission corridor impacts.

Table 1. Highest Priority Habitat Areas and Wildlife Groups Along the Columbia River and Tributaries Needing Protection from Future Inundation

River	Location	State	Key Habitat or Wildlife	Impact	Proposed Action
Columbia	Hanford	WA	Waterfowl, upland birds, big game, raptors	Future inundation, land alteration, ROW, fluctuation	Protection
Snake	Lower Hells Canyon Bottomland ≤ 3500' el.	ID/OR/ WA	Big game winter range, waterfowl wintering, upland birds, raptors	Future inundation, land alteration, ROW	Protection
	South Fork	ID	Big game, upland birds, waterfowl, raptors	Future inundation fluctuation	Protection
Grays	River and tributaries Bottomland ≤ 2000' el.	WA	Big game winter range, upland bird habitat	Future inundation, land alteration, ROW	Protection
Cowlitz	River and tributaries Bottomland ≤ 2000' el.	WA	Big game winter range	Future inundation, land alteration, ROW	Protection
Wind	River and tributaries Bottomland ≤ 2000' el.	WA	Big game winter range	Future inundation, land alteration, ROW	Protection
White Salmon	River and tributaries Bottomland ≤ 2000' el.	WA	Big game winter range	Future inundation, land alteration, ROW	Protection
Klickitat	River and tributaries Bottomland ≤ 2000' el.	WA	Big game winter range	Future inundation, land alteration, ROW	Protection

Table 1. (continued)

River	Location	State	Key Habitat or Wildlife	Impact	Proposed Action
Yakima	River & tributaries Bottomland ≤ 3000' el.	WA	Raptor and waterfowl nesting and wintering	Future inundation, land alteration, ROW	Protection
Wenatchee	River & tributaries Bottomland ≤ 3000' el.	WA	Big game winter range	Future inundation, land alteration, ROW	Protection
Entiat	River & tributaries Bottomland ≤ 3000' el.	WA	Big game winter range	Future inundation, land alteration, ROW	Protection
Methow	River & tributaries Bottomland ≤ 3000' el.	WA	Big game winter range	Future inundation, land alteration, ROW	Protection
Okanogan	River & tributaries Bottomland ≤ 3000' el.	WA	Waterfowl and raptor nesting and wintering, big game winter range, sharptail grouse sensitive habitat	Future inundation, land alteration, ROW	Protection
Similkameen	River & tributaries Bottomland ≤ 3000' el.	WA	Big game winter range, sharptail ground sensitive habitat	Future inundation, land alteration, ROW	Protection
Kettle	River & tributaries Bottomland ≤ 2500' el.	WA	Big game winter range	Future inundation, land alteration, ROW	Protection
Grande Ronde	Entire river and tributaries Bottomland ≤ 3500' el.	WA/OR	Big game winter range, upland game habitat	Future inundation, land alteration, ROW	Protection
Willamette Tributaries	Rivers & tributaries Bottomland ≤ 2000' el.	OR	Upland game habitat, big game winter range	Future inundation, land alteration, ROW	Protection

Table 1. (continued)

River	Location	State	Key Habitat or Wildlife	Impact	Proposed Action
Crooked	River & tributaries Bottomlands ≤ 3000' el.	OR	Big game winter range	Future inundation, land alteration, ROW	Protection
John Day	River & tributaries Bottomland ≤ 3500' el.	OR	Big game winter range	Future inundation, land alteration, ROW	Protection
Umatilla	River & tributaries above Pendleton Bottomland ≤ 3500' el.	OR	Big game winter range	Future inundation, land alteration, ROW	Protection
Immaha	Entire river and tributaries Bottomland ≤ 3500' el.	OR	Big game winter range, upland game habitat	Future inundation, land alteration, ROW	Protection
Wenaha	River & tributaries Bottomland ≤ 3500' el.	OR	Big game winter range	Future inundation, land alteration, ROW	Protection
Clearwater	River & tributaries Bottomland ≤ 3500' el.	ID	Upland game habitat, big game winter range	Future inundation, land alteration, ROW	Protection
Lochsa	River & tributaries Bottomland ≤ 3500' el.	ID	Upland game habitat, big game winter range	Future inundation, land alteration, ROW	Protection
Selway	River & tributaries Bottomland ≤ 3500' el.	ID	Upland game habitat, big game winter range	Future inundation, land alteration, ROW	Protection
Coeur D'Alene	North fork and tributaries Bottomland ≤ 2500' el.	ID	Big game winter range	Future inundation, land alteration, ROW	Protection

Table 1. (continued)

River	Location	State	Key Habitat or Wildlife	Impact	Proposed Action
St. Joe	River & tributaries Bottomland ≤ 2500' el.	ID	Big game winter range	Future inundation, land alteration, ROW	Protection
Kootenai	River & tributaries Bottomland ≤ 2300' el.	ID	Big game, upland birds, waterfowl	Future inundation fluctuation, ROW	Protection
Salmon	River & tributaries	ID	Big game, upland birds, raptors	Future inundation, fluctuation, ROW	Protection
Payette	South Fork/ Middle Fork	ID	Big game winter range	Future inundation, ROW	Protection
Big Lost	River & tributaries Bottomland ≤ 6000' el.	ID	Big game, upland birds	Future inundation, ROW	Protection
Boise	River & tributaries Bottomland ≤ 3000' el.	ID	Big game, upland birds	Future inundation, ROW	Protection
Owyhee	River & tributaries	ID/OR	Big game, upland birds, raptors	Future inundation, ROW	Protection
Bruneau	River & tributaries	ID	Big game, upland birds, raptors	Future inundation, ROW	Protection

Table 2. Priority Habitat Areas and Wildlife Groups Along the Columbia River and Tributaries Needing Mitigation for Initial Inundation or Water Level Fluctuations

River	Location	State	Key Habitat or Wildlife	Impact	Proposed Action
Columbia	Bonneville/ The Dalles	WA/OR	Goose nesting, raptors	Initial inundation, fluctuation	Protection, mitigation
	John Day	WA/OR	Waterfowl, upland birds, big game	Fluctuation	Protection, mitigation
	McNary	WA/OR	Waterfowl, upland birds, raptors, aquatic mammals	Initial inundation, fluctuation	Protection, additional mitigation, enhancement
	Hanford	WA	Waterfowl, upland birds, big game, raptors	Fluctuation	Protection, mitigation
	Priest Rapids/ Wanapum	WA	Waterfowl, big game	Fluctuation	Protection, mitigation
	Rock Island	WA	Big game, waterfowl, upland birds	Fluctuation	Protection, mitigation
	Rocky Reach	WA	Big game, waterfowl, upland birds	Fluctuation	Protection mitigation
	Wells	WA	Waterfowl, upland birds, big game	Fluctuation	Protection mitigation
	Chief Joseph/ Grand Coulee	WA	Big game, upland game, aquatic mammals, terrestrial mammals, raptors	Initial inundation, fluctuation	Additional mitigation, protection, enhancement
Snake	Hells Canyon	ID/OR	Big game winter range, upland birds, raptors	Initial inundation	Additional mitigation, enhancement
Cowlitz	Mayfield-Mossyrock	WA	Big game, upland birds, aquatic mammals, waterfowl, raptors	Initial inundation	Additional mitigation, enhancement

Table 2. (continued)

River	Location	State	Key Habitat or Wildlife	Impact	Proposed Action
Lewis	Yale/Merwin/Swift	WA	Big game	Initial inundation	Additional mitigation, enhancement
Spokane	Spokane Falls/ Upriver Dam/Long Lake/Ninemile	WA	Big game, upland birds, waterfowl, aquatic mammals, raptors	Initial inundation	Additional mitigation
Pend Oreille	Boundary	WA	Big game, upland game, raptors	Initial inundation	Additional mitigation, enhancement
Willamette Tributaries	Cougar/Lookout Point/Dexter/ Hills Creek	OR	Big game winter range	Initial inundation	Additional mitigation, enhancement
Santiam	Green Peter/Foster	OR	Big game winter range	Initial inundation	Additional migitation, enhancement
Deschutes	Round Butte Dam	OR	Resident deer habitat	Initial inundation	Additional mitigation, enhancement

Table 3. Key Habitat Areas and Wildlife Groups Along Power Corridors in the Columbia Basin Needing Protection or Mitigation

Region	Location	State	Key Habitat or Wildlife	Impact	Proposed Action
S. Idaho E. Oregon	Future midpoint-Malin 500 kv trans. line	OR/ID	Upland birds, terrestrial mammals, raptors, waterfowl	Future ROW management, land alteration	Protection, mitigation
W. Montana N. Idaho E. Washington	Future hot springs-Bell 500 kv trans. line	MT/ID/WA	Waterfowl, terrestrial mammals, raptors, nongame	Future ROW management, land alteration	Protection, mitigation
S. Idaho	Existing trans. lines: Hells Canyon Complex, Upper Snake River	ID	Upland birds, terrestrial mammals, raptors, nongame	Existing ROW management, land alteration	Additional mitigation
N. Idaho	Existing trans. lines: Dworshak	ID	Terrestrial mammals, upland birds, nongame, big game	Existing ROW management, land alteration	Additional mitigation
E. Oregon	Existing trans. lines: McNary, John Day, The Dalles, Hells Canyon Complex	OR	Upland birds, terrestrial mammals, nongame, waterfowl	Existing ROW management, land alteration	Additional mitigation
W. Oregon	Existing trans. lines: Bonneville, Willamette Tributaries	OR	Upland birds, terrestrial mammals, nongame, waterfowl	Existing ROW management, land alteration	Additional mitigation
E. Washington	Existing trans. lines: Upper Columbia, Mid Columbia, Lower Columbia, Lower Snake	WA	Upland birds, terrestrial mammals, waterfowl, nongame	Existing ROW management, land alteration	Additional mitigation
W. Washington	Existing trans. lines: Bonneville, Cowlitz, Lewis	WA	Terrestrial mammals, big game, nongame, waterfowl	Existing ROW management, land alteration	Additional mitigation

Each of the three States listed its highest priority projects; those needing protection from future inundation or mitigation of past inundation and fluctuation impacts. Those projects that occurred on the boundaries of two States are discussed under the section "Interstate Programs." Those projects lying entirely within one State are discussed individually under "Intrastate Programs."

5.3 Interstate Programs

5.3.1 Projects

The projects considered in this section are those involving more than one State that are considered high priority for protection, mitigation, and enhancement. The five projects are the Hells Canyon Complex on the Snake River; Bonneville, The Dalles, John Day, and McNary Dams on the Columbia River. All five of the projects were inundation projects that had significant negative impacts on habitat and wildlife that were either unmitigated or unsatisfactorily mitigated. The four Columbia River projects are also listed as priority projects for protection for and mitigation and enhancement of water level fluctuation impacts.

5.3.2 Impacts

The Hells Canyon complex consists of three major hydroelectric projects on the Snake River bordering Idaho and Oregon. All of the projects were constructed by Idaho Power Company.

Brownlee Dam, located at RM 285, was completed in 1959. The reservoir is approximately 15,000 surface acres at full pool, and inundates 55 miles of the Snake River.

Oxbow Dam, located at RM 273, was completed in 1961. The reservoir is 13 miles long and has a capacity of 1,145 surface acres at full pool.

Hells Canyon Dam is located at RM 247 and was completed in 1968. The reservoir is 2,500 surface acres at full pool and is 23 miles long.

Inundation by these three dams flooded big game habitat that was used primarily during the winter and spring. Data compiled several years following inundation (Asherin and Claar, 1976) indicate moderate-to-heavy use by mule deer along the undeveloped portions of the shorelines. Prior to inundation this use extended to and included the riparian zone along the river.

The three dams were authorized for construction under FERC licensing. Mitigation provisions were included for loss of upland bird and waterfowl habitat by the acquisition of three islands in the free-flowing stretch of Snake River above the Brownlee pool. No mitigation was included for the loss of big game and terrestrial mammal habitat.

Bonneville Dam, completed in 1938, inundated 47 miles of the Columbia River. Losses of nesting habitat and riparian vegetation impacted waterfowl, raptors, songbirds, and terrestrial mammals. Waterfowl use the pool for nesting at the present time. A recent nest search revealed 95 goose nests on Bonneville Pool (Tabor et al, 1980). Bonneville Pool

fluctuates 3 feet daily, causing erosion of islands and the shorelines and posing a threat to the security of nesting and brooding geese. Wildlife losses due to inundation and fluctuation of Bonneville Dam have never been mitigated.

The Dalles Dam, completed in 1968, inundated 24 miles of the Columbia River and formed an 11,000-acre lake. Losses of riparian vegetation and island habitat due to inundation have severely impacted wildlife in this dry, rather barren area. Some nesting by geese, ducks, and gulls occurs on the reservoir, the area is also used for resting by migrating waterfowl (USAEC, 1975). The pool has a daily fluctuation of 3 feet, which is causing erosion of islands and shorelines and causing problems for nesting/brooding waterfowl.

John Day Dam, completed in 1968, inundated 77 miles of the Columbia River and formed a 55,000-acre reservoir. Wildlife habitat losses due to inundation were extensive (USFWS, 1961). A preimpoundment study by the USFWS (1961) predicted a loss of 50% of the mule deer harvest, 80% of the pheasant habitat, 26 nesting islands, and 2,669,000 waterfowl usedays in the project area, along with losses of aquatic and terrestrial mammals. Wildlife losses have been partially mitigated by acquisition and management of lands for wildlife, but opportunities exist for further mitigation. John Day reservoir has a daily fluctuation of 3 feet and operating extremes of 11 feet, and erosion of islands and shorelines is a problem. Fluctuations cause problems for nesting/brooding waterfowl, denning aquatic mammals, and deer that fawn on islands in the reservoir (Tabor et al, 1980).

McNary Dam, completed in 1953, inundated 53 miles of the Columbia River, including extensive waterfowl nesting/wintering habitat. A total of 23 nesting islands were inundated (Hansen and Oliver, 1960) along with goose brooding areas and sloughs. Harvest records show a decrease in average annual duck harvest in the project area of 15,225 ducks/year after inundation. Goose harvest decreased by 853 geese/year after inundation (Washington Dept. of Game harvest records). Wintering waterfowl in the area have peak populations in the hundreds of thousands (USFWS, 1979). Upland birds, beaver, muskrat, raptors, songbirds, shorebirds, and colonial birds also inhabit the area. McNary Pool has a daily fluctuation limit of 5 feet and operating extremes of 15 feet. Increased fluctuation following the construction of the second powerhouse at McNary Dam will result in additional adverse impacts on wildlife. Impacts identified by the USFWS (1975) that will occur as a result of the second powerhouse include decreased waterfowl production, increased waterfowl mortality due to predation, a decrease in waterfowl feeding and resting in the area, and stress on fur mammals during the whelping season. Losses at Paterson Slough (John Day Pool) are expected to amount to a 25% decrease in annual waterfowl producion accompanied by a decrease of 214,000 waterfowl use-days (USFWS, 1975). McNary Project has been partially mitigated by acquisition and management of lands for wildlife, but opportunities exist for further mitigation.

Unmitigated delayed development of shorelines has also impacted wildlife and habitat along lower Columbia reservoirs.

Some unmitigated, but authorized, uses of public shorelands include:

1. Irrigation pumping plants - Directly occupy riparian habitat; serious secondary impacts include conversion of big game winter range (Columbia and Snake Rivers)

2. Industrial and recreational developments - Directly occupy and destroy riparian habitat, introduce harassment and disturbance factors, pollution, and often dredging and spoil disposal (Columbia and Snake Rivers)

3. Private use facilities - PUD's often permit private use of shorelands, pumping plants, orchards, pastures, boat docks, lawns, garbage, fencing, etc., excluding wildlife and public use (mid-Columbia PUD's).

4. Transmission corridors - Sometimes cross wildlife mitigation projects (Crow Butte, McNary WRA, etc.)

Proposed corrective actions include:

1. Requiring mitigation of wildlife impacts through existing permit systems;
2. Disallow wildlife habitat to develop on reservoir shorelands not designated for wildlife; or
3. Designating wildlife as a principal use of public shorelands, requiring conflicting uses to pursue other channels for permission to develop.

5.3.3 Protection, Mitigation, Enhancement Measures

All five projects should be protected from further inundation and fluctuation impacts. Flooding of important islands,

shorelands, and riparian habitats used by wildlife should be avoided. Goose nesting islands in John Day and McNary pools should be protected from future operational changes such as pool raises. Short-term fluctuations at islands, shorelands, and riparian habitats used by wildlife during important use periods should be avoided or minimized. Specific recommendations to protect important wildlife use periods include:

Canada Goose nesting: late February through mid-June
Duck nesting: mid-March through mid-June
Colonial birds nesting: early March through August
Beaver and muskrat denning: February to mid-September

During nest and den site selection, the maximum water level expected during the nesting/denning period should be reached at least once every 3-4 days to encourage selection of secure nest/den sites (Tabor et al 1980).

Establishing general minimum and maximum water levels during key use periods by wildlife would also protect wildlife and habitat in the five projects. Fielder (1978) determined monthly maximum fluctuation and maximum and minimum river elevations tolerable for wildlife activities in each reach of the Columbia and Lower Snake Rivers. These and additional recommendations for protection have been discussed in greater detail in Section 3.

It is recommended that unmitigated losses of wildlife on Wells Dam, Bonneville, and The Dalles projects be mitigated. Additional mitigation of initial inundation and water fluctuation impacts is recommended on McNary, John Day, The Dalles, and Bonneville pools.

Loss of big game winter range in Hells Canyon caused by the Hells Canyon Complex should be mitigated by acquisition of lands adjacent to the reservoir and management of those lands for big game.

Mitigation of the lower Columbia pools could be accomplished by limiting daily fluctuations to less than 3 feet; replacing riparian vegetation; creating subimpoundments not subject to fluctuations; or dedicating shorelines, reservoirs, or reaches to wildlife management by pool stabilization. Examples of the latter are John Day, McNary, and Hanford, where wildlife use if high, and potential for wildlife management is great. Stabilization of water levels in any one or all of these reservoirs would greatly improve habitat for deer, geese, and furbearers in particular. Specific locations for replacing riparian vegetation include all Columbia River reservoirs. Recommended sites for creation of subimpoundments include (from Tabor et al, 1980):

Below Bonneville - Washington shore (RM 123); Sand Island, slough at SW end (RM 131): Arthus Lake (RM 137-139): Pierce Island (slough in center or island) (RM 142); Ives Island (slough near north shore) (RM 142.7).

Bonneville Pool - Oregon shore (RM 152.1); Oregon shore (RM 166.5): Oregon shore (RM 182.3); Oregon shore (RM 183.2); and Oregon shore (RM 190-191).

The Dalles Pool - Oregon shore (RM 197); Oregon shore (RM 210-212)

John Day Pool - Whitcomb Island slough (RM 265.5-269.2): several small sloughs on Washington shore (RM 273-276): Oregon shore (RM 272-274): Paterson Slough (RM 278-280); one large subimpoundment or several small ones; and Washington shore (RM 290.3).

McNary Pool - Slough on south bank of mouth of Walla Walla River; Slough on north bank of mouth of Walla Walla River; one large or several small subimpoundments at mouth of Burbank Slough (RM 218); several sloughs on east shore (RM 323-324.5); and many possibilities in Yakima River delta area (RM 334.5-335).

These mitigation recommendations, and others, are discussed more completely in Section 3. Enhancement measures for the five projects include acquisition, development, and management of replacement habitat offsite, for development of food, cover, and watersheds of impacted species. Evaluation of suitable habitat should be made on a project-by-project basis. Replacement habitat should possess as many of the following qualities as possible:

(1) An area capable of improvement for impacted species, using habitat management techniques.

(2) Located as close to the impact area as possible

(3) An area containing critical habitat for impacted species.

Specific measures and locations for enhancement on the interstate projects are not available at this time, and warrant additional investigation.

Additional enhancement measures are discussed in greater detail in Section 3.

5.3.4 Additional Studies

Additional studies are needed to identify sites, opportunities, and measures for protection, mitigation, and enhancement of habitat and wildlife. Investigations specific to each reservoir should be conducted to develop baseline habitat and wildlife data and to test and evaluate mitigative measures. Additional studies are discussed further in Section 4.

5.4 Intrastate Programs

5.4.1 Washington Program

Six projects on the Columbia River in Washington were prioritized for protection, mitigation, and enhancement of wildlife and habitat. Those six projects are, in order of priority: (1) protection of the Hanford Reach from future inundation, (2) mitigation of inundation impacts of Grand Coulee Dam, and (3) mitigation of water-level fluctuations in and initial inundation of McNary, John Day, The Dalles, and Bonneville pools.

The Hanford and Grand Coulee projects are discussed in this section. Because the four lower Columbia Dams also occur in Oregon, those projects are discussed in the section "Interstate Programs."

a. Hanford

The Hanford Reach is the last remaining free flowing section of the Columbia River. The reach extends from RM 350 to RM 397, a total of 47 miles. The reach is bounded by Priest Rapids Dam at the upstream end, and the tailwater of McNary Dam at the downstream end. Water releases from Priest Rapids Dam cause water level fluctuations ranging from 5 to 15 feet (Fielder and Perleberg, 1981).

Many wildlife species are present along the Hanford Reach. Some of the more important species are waterfowl, mule deer, and raptors.

The reach is important to waterfowl at all seasons of the year. An estimated 300 adult pairs of Canada geese nest on the islands and produce 800-1,000 goslings per year (Col. R. Cons. League, 1969). This constitutes about 1/7th of the State's total goose production (USFWS, 1969). The reach is extremely important to wintering waterfowl; prior to 1970, peak populations observed were 18,000 geese and 300,000 ducks (USFWS, 1969). Counts more recently indicate up to 40,000 geese and 150,000 ducks (Blomstrom & Detrick, 1980). Mallards constitute about 90% of the ducks using the area. Other waterfowl species commonly seen include greenwinged teal, pintail, American widgeon, and goldeneye. Less frequently observed are bufflehead, scaup, gadwall, canvasback, and merganser.

The islands in the Hanford Reach are also important for deer fawning. At least 120 mule deer inhabit the riparian bottomlands and islands (Tabor et al, 1980) and produce an estimated 40-50 fawns annually (USDI,

1979). The islands offer some protection from predators, especially coyotes.

The area has the most diverse raptor population of any stretch of the Columbia. Twenty-one species of raptors occur in the area. At least ten species nest along the Reach. The Hanford segment is one of the major wintering areas of the threatened bald eagle in eastern Washington. The endangered peregrine falcon has been observed in the area. The golden eagle, ferruginous hawk, Swainson's hawk, burrowing owl, and barn owl, all listed in Washington State as "species of concern," occur in the area.

A variety of other nongame birds occur in the area: long-billed curlew, great blue heron, white pelican, common loon, cliff swallow, Forster's tern, ringbilled and California gulls. A complete checklist of birds would include 150-200 species.

Coyotes are common to the Hanford Reach and are the primary predator. A variety of other terrestrial and aquatic mammals are present including bobcat, hare, raccoon, beaver, muskrat, mink, and several species of rodent.

(1) Impacts

Inundation of the Hanford Reach by a proposed Ben Franklin Dam would inundate approximately 11,500 acres of land, including 200 acres on 15 river islands (USFWS, 1969). It would destroy the last remaining free flowing stretch of Columbia River in the U.S.

The project would inundate riverine mule deer habitat and islands valuable as fawning grounds. The combined loss of food, shelter, and fawning grounds would virtually eliminate the deer. Average annual loss for the project life would be about 1,275 participant-days of hunting (USFWS, 1969).

Shrub and grass habitat on shore island areas, especially important for survival of California quails, ring-necked pheasants, and chukars, would be inundated by the reservoir. Consequently, a reduction in upland game bird populations would result in an average loss of 3,180 man-days of hunting for the project life (USFWS, 1969).

Beavers would be virtually eliminated with the project. Other fur animals in the project area would not be significantly affected (USFWS, 1969).

The reservoir would completly inundate 15 islands, totalling about 350 acres, which contain valuable waterfowl nesting habitat. Approximately 80 percent of the remaining Columbia River island goose nesting habitat within the United States would be destroyed (USFWS, 1969). A number of small islands and a sizeable peninsula complex would be formed by flooding to the 400' maximum storage level. This complex, however, would have little value without development. Lack of suitable vegetation and

uncontrolled depredation by predatory animals would minimize goose and duck production. Additional shoreline and the new islands created with the project would be expected to offset the loss of without-the-project resting areas used by wintering waterfowl (USFWS, 1969). Based upon waterfowl productivity associated with the reservoir the project would result in an average annual loss of 2,100 goose-hunter-days and 325 duckhunter-days (USFWS, 1969).

Ben Franklin Reservoir would inundate important habitat for a variety of nongame wildlife including songbirds and gulls. Gull island nesting sites would be destroyed. Bald eagle roost sites and the great blue heron rookery would likely be inundated.

Existing water level fluctuations in the Hanford Reach have a negative impact on nesting wildlife in particular. At low water elevations, land bridges to the islands are created, making them easily accessible to coyote predation. Coyotes are the most important predator of goose

nests. In 1966 on Island 6, coyotes destroyed 24 of 80 goose nests and caused five to desert (Hanson and Eberhardt, 1971). Land bridges, which increase the likelihood of coyote predation, also have a negative impact on deer fawning. Wave action associated with fluctuating water levels increases erosion of nesting islands and destroys nesting habitat (Tabor et al, 1980).

Aquatic furbearers, such as beaver and muskrat, are impacted by fluctuations. Fluctuations cause flooding and exposure of dens and houses, which increase mortality.

(2) Protection and Mitigation Measures

We recommend that future hydroelectric development be avoided in the Hanford Reach in order to protect its habitat and wildlife. This is of the highest priority in the State. Other sites less damaging to wildlife would be preferred as potential dam sites.

Recommended mitigation and enhancement measures to protect against impacts of water fluctuation include: (1) avoiding or minimizing water fluctuations during important wildlife use periods, and (2) creating subimpoundments not subject to fluctuation.

Important use periods would include:

Canada goose nesting: late February through mid-June

Duck nesting: mid-March through mid-June

Colonial bird nesting: early March through August

Beaver and muskrat denning: February-mid September

Recommended sites for creation of subimpoundments include:

Hanford Reach - Wooded Island sloughs (RM 348.5-350); sloughs on east bank (RM 351); sloughs on Island (RM 352); Savage Island slough (RM 356.5-359.5); west bank (RM 362.5); sloughs on west bank (RM 365-367); slough on east bank (RM 367.5-368); slough on east bank (RM 370); slough on west bank (RM 370). Biological desirability of diking these sloughs should be carefully evaluated because of potential anadromous and resident fish use.

These recommendations are discussed more fully in Section 3.

(3) Additional Studies

Baseline studies to determine wildlife impacts from any future inundation and increased fluctuations need to be performed. Pre- and post-dam surveys should be conducted on all wildlife species likely to be impacted by a proposed dam. A program to mitigate losses of wildlife and habitat should be investigated and formulated. Additional studies are further described in Section 4.

b. Grand Coulee Dam: F.D.R. Reservoir

(1) Impacts:

Franklin D. Roosevelt (F.D.R.) Reservoir was created in 1939 by the construction of Grand Coulee Dam, the largest hydroelectric power production installation in the Pacific Northwest. Although this project inundated over 80,000 acres, affecting 151 miles of the Columbia River and 1,140 miles of tributaries, wildlife impacts have never been adequately mitigated or compensated.

In its natural state, the Columbia River in this region was bordered by riparian corridors of successionally developed communities with excellent cover and high food value to wildlife. This edge was characterized by inherent fertility, maturity, and volume. The shorelines of the river were quite rocky, and scattered ponderosa pine, cottonwood, juniper, dogwood, and willow dominated the overstory. The moderate microclimate of this low elevation vegetative corridor offered wildlife protection during periods of environmental stress (Oliver and Barnett, 1966). In addition, the inundation zone contained at least 3,000 acres of cultivated land, 5,000 acres of lakes and wetlands, and 19,000 acres of sagebrush and desert habitat. Prior to inundation the area supported large populations of wildlife, including deer, pheasant, black bear, mourning doves, several species of grouse, waterfowl, and numerous raptors/nongame species. Deer were highly dependent upon low elevation sidehills, draws, and bottom farmlands for winter range along the Columbia River since most of the valuable deer winter range in northeastern Washington exists below 2,500 feet elevation.

Grand Coulee Dam inundated much of this habitat, causing an estimated loss of between 5,000 to 10,000 deer in the area. Over 50,000 mandays of hunting and an equal amount of appreciative recreation were lost due to inundation of this prime winter range.

The lowlands along the Columbia River also supported other wildlife populations with significant recreation potential. Records indicate some 6,684 black bear pelts were received at Fort Colville over a 30-year period from 1826 to 1856. This population was influenced by the Upper Columbia River and its salmon runs. In addition, project construction probably precluded the possibility of maintaining remnant populations of grizzly bear. Pheasant populations were unimportant in the Upper Columbia River gorge when the project was completed, but their importance would have increased with time. Based on arable acreage and average population parameters for similar areas, production of 5,000 pheasants was negated by project construction. Similar calculations indicate that more than 100,000 mourning doves were negated by inundation impacts (Wendell H. Oliver, WDG, pers. comm.). Other game birds also flourished in the area prior to inundation. Sage grouse were abundant in some areas but not as common as sharptailed grouse, according to records. Scaled quail, an exotic species, was present in various locations. Records show that a wide variety of waterfowl and shorebirds was produced in the area. These populations have declined due to project-related impacts.

Raptor/nongame species affected by project development include whooping crane, sandhill crane, prairie and peregrine falcon, and kangaroo rat, all of which appear on Federal and/or State endangered/threatened lists.

In addition to inundation impacts, additional habitat was lost during construction of the dam, roads, borrow areas, transmission facilities, and transmission rights-of-way. Construction of the dam resulted in the loss of over 1,500 acres in the vicinity of the dam site. Wildlife losses attributed to these activities should be considered along with inundation losses as specific compensation measures are formulated.

Impacts related to water level fluctuations have already occurred and will continue following commencemnt of peaking operations. Grand Coulee's third powerhouse is expected to cause daily river fluctuations of 30 feet immediately below the dam. Historical operating extremes in F.D.R. Reservoir have ranged from 1,211.6 feet msl to 1,290.0 feet msl, a difference of 78.4 feet. Fluctuations of this magnitude reached on a shortterm basis create a hazardous situation for recreationists and a deleterious situation for fish and wildlife. Riparian and wetland areas have established slowly since project completion and are expected to be eliminated as a result of: (1) fluctuation-induced erosion, (2) extended storage of maximum forebay water water volumes, and (3) higher outflow volumes. Additional impacts due to water level fluctuation are listed in Section 2 of this document.

(2) Protection/Mitigation/Enhancement Measures

Protection and mitigation measures for current and anticipated wildlife impacts should follow recommended techniques presented in Section 3.

Compensation lands should be acquired in order to replace wildlife and habitat lost due to inundation and construction activities. An initial survey of potential big game and upland game mitigation lands along F.D.R. reservoir was made by Fielder (1977). Suitable river corridors below 3,000 feet elevation should be purchased to compensate loss of prime winter range and increase wildlife production. Specific drainages to be evaluated include reaches of the Columbia, Pend Oreille, Colville, Kettle, Okanogan, Sanpoil, Curlew, and Methow Rivers.

Further development of reservoir shorelines should be subject to zoning in order to protect valuable wildlife habitats. Since much of the area surrounding the reservoir remains winter range, further development should be discouraged.

(3) Additional Studies

Since little biological work has been done in the area, intensive studies should be intiated to gather baseline data from the area in order to develop management alternatives. In particular, further studies to inventory existing habitats, current resident fish populations, and wintering deer populations will be invaluable in assessing compensation land needs and determining relevant mitigation/compensation techniques. Additional inventories of waterfowl, pheasant, and raptor/ nongame species should also be initiated to devise mitigation compensation plans for these groups. Additional studies are described in Section 4.

5.4.2 Idaho Program

The primary project recommended for wildlife mitigation in Idaho is the Hells Canyon complex, consisting of Brownlee, Oxbow, and Hells Canyon dams. Because the projects affect both Idaho and Oregon wildlife, they have been included in the priority projects of the Interstate Program. Under the FERC licensing agreement, impacts to upland bird and waterfowl were mitigated; however, losses to big game and terrestrial mammal habitats was not included.

In addition to Hells Canyon there are other hydroelectric power projects in Idaho. They are separated into different categories: (1) irrigation storage and flood control, (2) hydroelectric, and (3) early unmitigated projects.

a. Irrigation storage and flood control projects

This group of projects was constructed primarily for irrigation storage and flood control. Electric power generation units were included with the project, but generation is dependent upon discharge flows of the other uses. Impacts to wildlife from these projects can be attributed to irrigation demands and flood control and not necessarily hydropower generation. Examples are:

Project	Primary Wildlife Affected	Impacted by
Palisades	Waterfowl, big game	Initial inundation, water releases
American Falls	Waterfowl, upland birds	Initial inundation
Minidoka	Waterfowl, upland birds	Initial inundation
Anderson Ranch	Big game	Initial inundation
Cascade	Waterfowl, aquatic furbearers	Initial inundation
Black Canyon	Waterfowl, upland birds	Initial inundation

b. Hydroelectric projects

This group of projects was constructed primarily for hydroelectric power with storage and timed water releases to allow for some flood control. Wildlife mitigation was provided under the Wildlife Coordination Act and FERC licensing. Examples are:

Project	Primary Wildlife Affected	Impacted by
Dworshak	Big Game	Initial inundation
C. J. Strike	Waterfowl, upland	Initial inundation

c. Early unmitigated projects

These projects are some of the earliest hydroelectric projects developed in Idaho. The absence of preconstruction wildlife data makes it difficult to verify impacts and make mitigation recommendations. It is evident that initial inundation resulted in the loss of wildlife habitat, especially in the riparian zone; however, where pool fluctuations have been minimal, riparian areas have, in some instances, been partially reestablished. Examples are: Ashton, Swan Falls, Bliss, Post Falls, and Upper Falls.

Water fluctuations in te Post Falls project affected aquatic furbearers and waterfowl. Nesting waterfowl in the Albeni Falls project were affected by flooding in pool areas.

Studies of these projects are needed to determine measures and sites for protection, mitigation, and enhancement of habitat and wildlife.

5.4.3 Oregon Program

The top priority projects for mitigation of inundation impacts in Oregon are, in order of priority:

(1) Hills Creek Dam - Middle Fork Willamette River

(2) Cougar Dam - McKenzie River

(3) Green Peter/Foster Dams - Santiam River

(4) Lookout Point Dam - Middle Fork Willamette River

The above projects are combined major hydroelectric and flood-control on the Willamette River and tributaries. All are unmitigated for wildlife.

Other priority projects for mitigation of inundation and fluctuation impacts, and protection from further impacts:

Bonneville Dam
The Dalles Dam
John Day Dam
McNary Dam
Hells Canyon Complex

The above projects are on the mainstem Columbia and Snake Rivers. Bonneville and The Dalles have not been mitigated. Further opportunities for mitigation exist on John Day and McNary projects. Hells Canyon Complex has not been mitigated for loss of big game winter range. These projects have already been discussed in detail under "Interstate Programs."

a. Willamette River and Tributaries Projects

(1) Impacts

The major impact associated with the four Willamette River and tributaries projects was inundation of big game winter, spring, and fall ranges. It is estimated that 400 elk were lost as a result of habitat losses in the project area.

(2) Protection and Mitigation Measures

Suitable land for mitigation is located both on- and off-project, for the four areas. All of the reservoirs are adjacent to public lands which could be managed for wildlife. Additional public lands suitable for mitigation purposes are located immediately upstream from the reservoirs and are presently managed on a "multiple use" basis. The most desirable site is valuable winter range above Hills Creek Reservoir. This land currently receives heavy use by elk. Additional mitigation could be accomplished by seeding and fertilizing the drawdown zone of the reservoirs to provide winter forage for elk.

(3) Additional Studies

A study of the four projects is needed to determine the acreage needed to accomplish mitigation.

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Appendix I

GOAL, OBJECTIVES, SUBOBJECTIVES, AND TASKS FOR DEVELOPMENT OF THE SECTION 4(H) WILDLIFE PROGRAM UNDER THE PACIFIC NORTHWEST ELECTRIC POWER PLANNING AND CONSERVATION ACT P.L. 96-501

GOAL	Develop and support recommendations to the Northwest Power Planning Council for implementation of a program to protect, mitigate, and enhance habitat and wildlife where affected by electrical power development and operation of power generation and transmission facilities within the Columbia River system.
OBJECTIVE I	Assure that formal wildlife representation in all matters of power system planning, management, and operation is accomplished.
OBJECTIVE II	Identify and prioritize activities of electrical power development and operation that impact habitat and wildlife.
OBJECTIVE III	Recommend (identify) measures and locations to protect, mitigate, and enhance habitat and wildlife impacted by development and operation of the Columbia River Basin power system.
OBJECTIVE IV	Recommend additional investigations needed to document measures to protect, mitigate, or enhance habitat and wildlife impacted by development and operation of the Columbia River Basin power system.

OBJECTIVE I: WILDLIFE REPRESENTATION

SUBOBJECTIVE 1.1: Propose and support an organizational structure to represent wildlife interests in power matters.

TASK 1.1.1: Identify appropriate Indian, State, and Federal agency and other wildlife interests.

TASK 1.1.2: Describe a mutually acceptable structure to provide wildlife representation.

SUBOBJECTIVE 1.2: Establish a process that incorporates wildlife interest's participation and recommendation on power matters that affect habitat and wildlife.

TASK 1.2.1: Develop and propose guidelines for making decisions that may affect habitat and wildlife during preparation of local and systemwide operating plans.

TASK 1.2.2: Develop and propose guidelines for evaluating the acquisition of new power sources and other financial incentives that may cause individual project or cumulative impacts on habitat and wildlife.

TASK 1.2.3: Assure that all contractual agreements reflect obligations to protect, mitigate, and enhance habitat and wildlife.

OBJECTIVE II: WILDLIFE IMPACTS

SUBOBJECTIVE 2.1: Inundation - eliminates existing terrestrial habitat and wildlife in the direct impact area. Also causes changes in water quality, water quantity, micro and macro climate. Additional terrestrial habitat may be lost from associated land clearing relocation of structures and facilities, rights-of-way, borrow, and staging areas, bank erosion.

TASK 2.1.1: Big game - Inundation will cause loss of fawning and/or calving areas and loss of year-round food and cover. New reservoir may disrupt, bisect, or eliminate migration routes. Wintering areas may be destroyed.

TASK 2.1.2: Upland Birds - Upland birds will be impacted by direct loss of habitat. Loss of food and cover will affect nesting and migratory birds.

TASK 2.1.3: Terrestrial Mammals - Inundation will cause permanent loss of habitat for terrestrial mammals. Food availability will be reduced.

TASK 2.1.4: Waterfowl/Shorebirds - Inundation affects waterfowl/shorebirds particularly during nesting and brooding. Causes direct loss of nests and nesting/brooding areas. Wintering waterfowl may be impacted if wintering areas are inundated and may cause alterations of food sources and availability.

TASK 2.1.5: Aquatic Mammals - Inundation may cause permanent loss of denning areas and reduced availability of food.

TASK 2.1.6: Raptors/Nongame - Inundation can cause permanent loss of nest sites, wintering areas, and perches; reduced food availability may also result.

SUBOBJECTIVE 2.2: Water-level fluctuation - causes losses of terrestrial and aquatic habitat and wildlife, reduces or changes shoreline vegetation, and decreases food and cover for wildlife.

TASK 2.2.1 Waterfowl/Shorebirds - Fluctuations will cause flooding of nests and nesting areas and will cause land bridges to occur increasing potential for predation. Increased erosion of islands caused by fluctuations will destroy nesting habitat. Brooding areas can be flooded. Migrating and wintering waterfowl may be indirectly affected by changes in food availability.

TASK 2.2.2: Aquatic Mammals - Fluctuations will cause both flooding and exposure of dens which will increase mortality. Food availability will likely decrease.

TASK 2.2.3: Big Game - Fawning areas will be impacted by fluctuations. Creasion of land bridges may lead to increased predation of fawns. Riparian cover will be lost.

TASK 2.2.4: Raptors/Nongame - Fluctuations will cause a loss of riparian habitat and will result in decreased raptors and nongame wildlife populations. Cover and food will likely decrease.

TASK 2.2.5: Terrestrial Mammals - Fluctuations will decrease suitability of riparian habitat and cause decrease in terrestrial mammal populations.

TASK 2.2.6: Upland Birds - Loss of riparian habitat will result in a reduction in upland bird populations. Nesting-wintering birds dependent on riparian vegetation will be lost.

SUBOBJECTIVE 2.3: Land/Stream Alteration - directly and indirectly causes loss of habitat and wildlife. Habitats providing cover and food for wildlife often are cleared and filled. Water quality and quantity and toxic waste disposal also alter terrestrial habitat and cause loss of wildlife.

TASK 2.3.1: Upland Birds - Loss of habitat for cover, resting, nesting, and feeding from land alterations will impact upland birds.

TASK 2.3.2: Terrestrial Mammals - Loss of riparian cover for food, thermal protection, hiding, resting, denning, rearing results from land alterations.

TASK 2.3.3: Big Game - Land clearing or filling can reduce habitat for food, cover, breeding, and rearing for big game. Migrational routes can be altered.

TASK 2.3.4: Waterfowl - Land clearing or filling can impact waterfowl nesting and wintering areas. Decreased water quality or quantity may also reduce waterfowl populations. Toxic waste disposal can cause direct mortality and destroy useful habitats.

TASK 2.3.5: Aquatic Mammals - Can be impacted through destruction of habitat for cover, food, denning; and through potential toxic chemical contamination.

TASK 2.3.6: Nongame/Raptors - Loss of habitat for some species results from land alterations.

SUBOBJECTIVE 2.4: Right-of-way Siting, Design and Management - eliminates wildlife habitat along transmission corridors, roads, and other special use areas.

TASK 2.4.1: Big Game - Corridors through fawning or wintering areas can cause impacts.

TASK 2.4.2: Upland Birds - Loss of habitat will occur in some locations.

TASK 2.4.3: Terrestrial Mammals - Land clearing and management will destroy nesting, denning, and rearing habitat.

TASK 2.4.4: Waterfowl - Overhead transmission lines can cause mortality of migrating waterfowl. ROW management practices can decrease water quality, which affects nesting in some locations.

TASK 2.4.5: Aquatic mammals - Land clearing and/or increased sedimentation from ROWs will decrease riparian habitat and make it unsuitable for denning, rearing, etc.

TASK 2.4.6: Nongame/Raptors - Land clearing will destroy nesting and wintering habitat. Overhead transmission lines cause avian mortality (e.g., raptor electrocution).

OBJECTIVE III: PROTECTION, MITIGATION, AND ENHANCEMENT

SUBOBJECTIVE 3.1: Existing conditions and operational changes - Propose measures to protect, mitigate, and enhance habitat and wildlife where impacted from existing operations or from operational changes (2' pool raise at Wells, etc.)

TASK 3.1.1: Identify measures and locations to protect habitat and wildlife from impacts resulting from inundation, fluctuation, channelization, land alteration, and ROW management.

3.1.1.1: Avoid flooding of important islands, shorelands, and riparian habitats used by wildlife.

3.1.1.2: Avoid short-term fluctuations at islands, shorelands, and riparian habitats used by wildlife during important or critical use periods.

3.1.1.3: Establish general minimum and maximum water levels during key use periods for wildlife.

TASK 3.1.2: Identify measures and locations to mitigate impacts to habitat and wildlife resulting from inundation, fluctuation, channelization, land alteration, and ROW management.

3.1.2.1: Replace riparian vegetation at levels above maximum pool elevation. May require cultivation, irrigation, and fertilization; development opportunities exist on most impoundments in the Columbia Basin.

3.1.2.2 Create subimpoundments not subject to fluctuation to provide new brooding and rearing habitat, secure den sites and produce aquatic and shoreline riparian plant food and cover. Recommended for all reaches of the Columbia River. Possible locations would be all sloughs. A few of the specific sites are at RM: [illegible], 337, 562.5[illegible].

3.1.2.3: Zone or dedicate reservoirs or reaches with high wildlife potential for wildlife management by pool stabilization and intense shoreland management for wildlife in suitable sites. Techniques include bank sculpturing, reef construction, fencing, etc. Areas with high potential include John Day, McNary, Hanford Reach, Wells, Grand Coulee, Lower Granite, Hells Canyon, etc.

3.1.2.4: Improve wildlife carrying capacity of undisturbed portions of impacted sites by vegetation management, reducing disturbance, supplying food, cover, and water, and eliminating existing land/water management conflicts.

3.1.2.5: Regulate water levels during critical use periods - generally late February to mid-June for geese and ducks; April to June for beaver. Regulation of water level elevation during nest and/or den site selection should encourage animals to nest above maximum water elevation. Max water level elevation must be reached frequently (at least once every 3-5 days) during daylight hours. Location would be all Columbia River reservoirs.

3.1.2.6: Create and manage new waterfowl brooding areas. Place near existing and new nesting islands. Ensure establishment of vegetation. Some recommended locations are at RM: 251, 252-254, 253-258, 279, 355-366, 369-370, 567-563, 563, 5R, 569L, 587.5L.

3.1.2.7: (a) Protect islands from erosion by using riprap, pilings, log rafts 5-10 m offshore with openings 2-3 m wide at 20-30 m intervals. Some islands identified as needing protection are located at RM 112, 117, 116, 124, 125, 136, 178, 197, 203, 274, 275, 317, 322, 536, 587.5.

(b) Build new islands for nesting, fawning, denning. Locations should be at sites of former islands, protected from waves, or near existing or potential brooding areas. Some recommended locations include RM: 250-254, 253, 280-284, 318-322, 316-317, 568.5L, 576.4L, 568.5, 581.7, and others.

(c) Increase size and height of existing islands - making areas above max high pool elevation greater. Some recommended sites are at RM: 203, 256, 271-273, 274, 307.5, 526-543.

(d) Remove island land bridges to protect fawning, nesting, and denning wildlife from predation. Some recommended locations are: RM: 251, 254, 255, 277.5-278.5, 249, 265-67, 537.5, 299, 322.

3.1.2.8: Manage ROW corridors to produce more desirable wildlife habitat. Recommendations include:

(a) eliminate broadcase herbicide spraying
(b) establish cover lanes for big game crossings
(c) establish brush piles for wildlife
(d) modify towers or poles to prevent raptor electrocution
(e) leave vegetation screens to block ROW's from view
(f) top trees instead of eliminating them
(g) close ROW's access roads; avoid continuous maintenance roads (use dead end spur roads)
(h) manage for uneven-aged stand of vegetation along corridors to reduce line-of-sight distances
(i) grow wildlife food crops under transmission lines
(j) use topographic features to maximize vegetation diversity (leave mature trees where wires are higher)
(l) Construct perches and roosts on towers to benefit some species

These recommendations should be incorporated into management of all existing powerlines.

3.1.2.9: Provide artificial nest structures or den sites sites for goose and beaver, respectively; perches for raptors; roosts and shelters for upland birds.

TASK 3.1.3: Identify measures and locations to enhance habitat and wildlife impacted by inundation, fluctuation, channelization, land alteration, and ROW locations management.

3.1.3.1: Acquire, develop, and manage replacement habitat off-site for development of food, cover, and water needs of impacted species.

3.1.3.2: Remove conflicting land/water uses by altering existing management practices (landowner incentives).

3.1.3.3: Raise and release game farm reared wildlife in suitable habitats acquired for public use purposes.

SUBOBJECTIVE 3.2: Future Conditions - Propose measures to protect, mitigate, and enhance habitat and wildlife where impacts would result from future hydroelectric projects including large and small hydro projects.

TASK 3.2.1: Identify measures and locations to protect habitat and wildlife impacted by inundation, fluctuation, channelization, land alteration, and ROW location and management.

3.2.1.1: Locate temporary and permanent reservoirs away from areas used by big game (e.g., Rattlesnake, Swauk).

3.2.1.2: Avoid inundation of farmlands and/or bottomlands used by upland birds and other wildlife (e.g., Ben Franklin and Asotin Dam sites).

3.2.1.3: Retrofit existing sites where wildlife habitats have already been impacted (e.g., irrigation reservoirs).

3.2.1.4: Avoid critical and important riparian habitats when clearing, ripapping, dredging, disposing of spoils and wastes, construction diversions, relocation structures and facilities. This should be done for all future projects.

3.2.1.5: Persuade government to provide zoning protection, tax incentives, etc., to preserve wildlife habitat.

3.2.1.6: Manage critical and important wildlife habitats in ROW's (avoid clearing, road building, etc.).

3.2.1.7: Develop habitat plans for ROW's and commit ROW's to wildlife production.

TASK 3.2.2: Identify measures and locations to mitigate impacts to habitat and wildlife resulting from inundation, fluctuation, channelization, land alteration, and ROW location and management.

3.2.2.1: Replace or improve riparian vegetation.

3.2.2.2: Create subimpoundments - dike backwater slough areas.

3.2.2.3: Improve carrying capacity of undisturbed portions of impacted areas.

3.2.2.4: Regulate water levels during critical use periods (see 3.1.2.5).

3.2.2.5: Make channel alterations during least critical periods.

3.2.2.6: Manage ROW corridors for wildlife.

3.2.2.7: Provide artificial nest structures.

3.2.2.8: Construct ROW's during July-November period to reduce nest and wintering impacts.

TASK 3.2.3: Identify measures and locations to enhance habitat and wildlife impacted by inundation, fluctuation, channelization, land alteration, and ROW management.

3.2.3.1: Acquire, develop, and manage replacement habitat off-site for development of food, cover, and water needs of impacted species.

3.2.3.2: Remove conflicting land/water uses by altering existing management practices (landowner incentives).

3.2.3.3: Raise and release game farm reared wildlife in suitably improved replacement habitats, acquired for public use purposes as substitute for losses.

OBJECTIVE IV: INVESTIGATIONS

SUBOBJECTIVE 4.1: Identify additional information needed to protect, mitigate, or enhance habitat or wildlife impacted by inundation.

TASK 4.1.1: Develop baseline habitat and wildlife inventories in areas likely to be affected; identify and characterize critical and important habitats where not already accomplished.

TASK 4.1.2: Examine, develop, and test plans and measures to protect, mitigate, and enhance wildlife where inundation occurs.

TASK 4.1.3: Determine micro and macro climatic changes in project areas that impact habitat and wildlife.

TASK 4.1.4: Determine individual and cumulative impacts of small hydro construction and operations.

SUBOBJECTIVE 4.2: Identify additional information needed to protect, mitigate, or enhance habitat or wildlife impacted by water level fluctuations.

TASK 4.2.1: Examine, develop, and test plans and measures to protect, mitigate, and enhance wildlife (primarily on Snake and Columbia Rivers where inventories are complete).

TASK 4.2.2: Develop baseline habitat and wildlife inventories in areas likely to be affected; identify and characterize critical and important habitat where not already accomplished.

TASK 4.2.3: Determine individual and cumulative impacts of small hydro construction and operations.

TASK 4.2.4: Determine micro and macro climatic changes in project areas that impact habitat and wildlife.

SUBOBJECTIVE 4.3: Identify additional information needed to protect, mitigate, or enhance habitat and wildlife impacted by land alteration-Stream alteration

TASK 4.3.1: Develop baseline habitat and wildlife inventories in areas likely to be affected, identify and characterize critical and important habitats where not already accomplished.

TASK 4.3.2: Examine, develop, and test plans and measures to protect, mitigate, and enhance wildlife where land alteration occurs.

SUBOBJECTIVE 4.5: Identify additional information needed to protect, mitigate, and enhance habitat and wildlife impacted by rights-of-way location and management.

TASK 4.5.1: Develop baseline habitat and wildlife inventories in areas likely to be affected; identify and characterize critical and important habitats where not already accomplished.

TASK 4.5.2: Examine, develop, and test plans and measures to protect, mitigate, and enhance wildlife where ROW location and management occurs.

TASK 4.5.3: Evaluate differential wildlife use of ROW's in various life zones and habitats.

TASK 4.5.4: Measure and identify electric field or corona impacts on habitat and wildlife.

COLUMBIA BASIN WILDLIFE TECHNICAL COMMITTEE

History: The interagency Committee was formed in 1972 to coordinate wildlife investigations funded under the Corps of Engineers CR&T program. Investigations consisted of inventories of Columbia, Snake, and Clearwater River riparian resources and peaking effects studies. Under endorsement by fish and wildlife agency directors in 1976, the Committee sought to analyze broader wildlife issues in the Basin. This led to a March 1980 request by Pacific Northwest River Basins Commission for a report on wildlife issues and possible solutions for use in their Tradeoff Analysis program.

Committee Goals: To identify common northwest wildlife management and research problems, needs for problem solutions, and remedial measures; to provide guidance on applied management and research studies; to analyze water project-wildlife relationships; and to seek cooperation and coordination among concerned entities.

Membership:

Idaho Fish and Game Department	Ralph Pehrson
Washington Department of Game	Wendell Oliver, Jack Howerton
Oregon Department of Fish and Wildlife	Dan Carleson
U.S. Fish & Wildlife Service (Chairmanship)	Richard Giger, Bob Cleary
U.S. Army Corps of Engineers	Paul Peloquin, John McKern
U.S. Water & Power Resources Service	Bob Adair
Grant County Public Utility District	Mike Dell, Darrel Pock
Chelan County Public Utility District	Bernie Leman
Douglas County Public Utility District	Mike Erho, Jim McGee

Recent Activity : In the past year, the Committee has been developing a wildlife issues report to fulfill the request by PNWRBC. Under a structured matrix and issue ranking process, priority northwest wildlife problems, causal pathways, and remedial measures are being examined which represent consensus views of member organizations. This portion of the work is complete, and narrative report sections which detail major problems for various wildlife groups such as big game, waterfowl and shorebirds, aquatic mammals, upland birds, raptors, and so forth are being prepared. The report may be completed in 6 to 9 months.

Proposed Activity: The Committee appears to be in a position to strongly interact with other interests in a coordination of wildlife aspects under the Pacific Northwest Electric Power Planning and Conservation Act.

Appendix III

WILDLIFE PROTECTION, MITIGATION AND ENHANCEMENT COSTS

Costs of Existing Mitigation Facilities

Grant County PUD, builder of Wanapum and Priest Rapids Dams on the Mid-Columbia River in Washington, was required to mitigate wildlife by Federal Power Commission licensing stipulation. In 1963, an agreement between Grant County PUD and Washington Department of Game (WDG) was reached wherein PUD agreed to pay WDG a total of $550,000 over a period of 23 years. Acquisition of approximately 19,279 acres of wildlife habitat has been accomplished with PUD mitigation funds and $172,000 from other funds (Jenkins, 1964).

Lower Snake River wildlife loss compensation includes acquisition and development of non-project land, development and management of project lands and purchase and release of game farm-reared pheasants to reduce project-incurred wildlife losses. Costs of these measures were estimated at $6,245,880. Annual O&M costs were estimated at $78,850 (USFWS, 1972). Actual costs were much higher.

Rock Reach Dam on the Mid-Columbia River impounded important big game, upland game and mourning dove habitat. Chelan County PUD provided $330,000 for purchase of big game winter range and $100,000 for dove and upland game shooting areas, in 1960 dollars.

Wells Project wildlife mititation, on the MId-Columbia River, resulted in approximately 6,360 acres of land acquired at a cost of about $1.25 million to Douglas County PUD (McGee, 1981). The agreement also provides about $1.25 million to WDG for initial development and annual O&M of these lands. Capitalization of this sum provides about $73,000 annually for operations over the remaining 39 years of project life (Oliver, 1974).

In addition to land acquisition and O&M costs, Wells Wildlife Mitigation Agreement assigned key portions of Wells reservoir shorelands to exclusive wildlife management. The agreement also gave WDG the right to object or make recommendations to other easement requests for use of Wells Project lands (Anonymous, 1974).

The Wells Project Wildlife Mitigation Agreement represents the most complete, and successful, replacement of wildlife accomplished to date in the Northwest.

In Oregon, Applegate Dam (COE) Project mitigated deer winter range on USFS property. Evaluation is underway and appears highly successful (Dan Carleson, ODFW, pers comm.).

Cost Estimates for Specific Measures

Costs of specific wildlife mitigation techniques and measures vary by location, intensity, and time. Representative costs are available from several sources. Habitat improvement needs and costs were identified by the Columbia North-Pacific (NP) Study, Volume IV, (PNRBC, 1972).

Estimates of specific needs and costs in CNP subregions, provided by wildlife agencies, are included in this Appendix.

Specific estimates were also compiled by Wirth Assoc. (U.S.A.C.E., 1975) who developed information for Lower Snake River Wildlife Mitigation proposals. These estimates, reflecting September, 1974 price levels, are also shown.

The Walla Walla District, Corps of Engineers, updated plans and costs of Snake River Wildlife Mitigation (U.S.A.C.E., 1978), but withheld specific costs of plans and measures, (Section 5) from report drafts to agencies. This information should be available from the Walla Walla District. Land values in this region vary from $350 to $7,000 per acre.

Wildlife Economic Values

Wildlife managers have been generally reluctant to express wildlife values in economic terms. They have contended that wildlife's value is immeasurable or intangible, having combination values for aesthetics, quality of life, maintaining ecological balance and providing hunting and fishing satisfaction. But, faced with ever mounting losses of habitat as tradeoffs for higher "valued" uses, managers now are looking to monetary evaluations of wildlife as a means of reducing the "edge" other industry has when competing for land and water.

Without question, the annual recreation business produced by the presence of wildlife represents a major but often unacknowledged industry. The wildlife industry is a public industry, providing values to people of a state regardless of who owns the land or water.

The establishment of wildlife values by resource economists has been challenging; their approaches vary. Values placed on wildlife range from replacement cost for wildlife losses to public investment in wildlife recreation. In 1977, Washington Department of Game contacted four prominent economists at state universities to determine if use of economic data based on recreation expenditures was appropriate for expressing wildlife's value to residents of the State (Oliver et al, 1975). Their opinion was affirmative, that gross fish and wildlife values totalled $1 .146 billion in Washington in 1979, that wildlife-related industry supported about 44,000 jobs, and that wildlife spending generated over $134 million dollars in State and local taxes (Anonymous, 1977).

A number of economic studies designed to value fish, wildlife and habitat are abstracted in this section.

Literature on Mitigation Costs

USFWS. 1972. A special report on the Lower Snake River Dams; Ice Harbor, Lower Monumental, Little Goose, Lower Granite; - Washington and Idaho, Portland, OR, pp 36.

Jenkins, Herb. 1964. Grant County PUD News Release, 3 pp.

Oliver, W.H. 1974. Wildlife problems associated with reservoirs used for electrical power generation (with special emphasis on Wells hydroelectric project study). Applied Research Bulletin No. 3. Washington Department of Game, Olympia.

McGee, Jim. 1981. Content of letter to Ms. Gretchen Van Lom, Washington Department of Game, dated Nov. 2, 1981, PUD No. 1 of Douglas County, WA, 2 pp.

U.S.A.C.E. 1975. Design Memorandum for Wildlife Habitat Development on Project Lands - Lower Snake River Project. Compiled by Wirth Assoc. for U.S. Army Eng. Dist., Walla Walla, WA.

PNRBC. 1972. Comprehensive Framework Plans - Appendix XVI, Columbia-North Pacific Region - CNP technical staff - Pacific NW River Basins Commission, Vancouver, WA 59300.

U.S.A.C.E. 1978. Design Memorandum for Wildlife Habitat Development. Supplement No. 1, Lower Snake River, U.S Army Corps of Engineers, Walla Walla Dist.

Anonymous. 1974. A Resolution Authorizing the Execution of an Agreement between the District and the State of Washington Department of Game for Wildlife Mitigation. Douglas Co. PUD No. 1, East Wenatchee, WA. 9 pp.

Columbia North Pacific Study

Wildlife Improvement

Cost Estimates

COST ESTIMATE
WILDLIFE HABITAT DEVELOPMENT
LOWER SNAKE RIVER PROJECT

Price Level
September 1974

Reservoir	Total Planting Acres	Planting @ $150 Per acre	Planting @ $480 per acre	Planting @ $ 70 per acre	Planting @ $350 per acre	Traveling Unit Irrigation @ $300 per acre	Solid Set Irrigation @ $600 per acre	Power Line @ $1.50 per foot	Fencing @ $2.50 per foot	Misc. costs
Ice Harbor										
Habitat 1-S	56	6600	2880	420		13200	7200	1500		
Habitat 2-N	12		2880	420			7200	1500		
Habitat 3-N	144	14400		210	15750	42300	1800			
Habitat 4-S	24		2880	420			7200	1500	26250	
Habitat 5-N	72	7200		1680		14400	14400			
Habitat 6-S	24	1800	2880	420		3600	7200	1500		
Habitat 7-S	17		7680	70			10200	1500	26250	
Habitat 8-N	24		11520				14400	1500		
Habitat 9-N	21		10080				12600			
SUB-TOTALS	394	30000	40800	3640	15750	73500	82200	9000	52500	
Lower Monumental										
Habitat 11-N	137	16050	4800	1400		32100	18000		210000	
Habitat 12-S	71	10650				21300			9000	
Habitat 13-S	5		2400				3000	1500	41000	
Habitat 14-N	86				30100				32500	
Habitat 15-N	107	7200		840	16450	28500	7200	1500		
SUB-TOTALS	406	33900	7200	2240	46550	81900	28200	3000	292500	
Little Goose										
Habitat 21-S	18		5760	420			18000	3000	85000	
Habitat 22-N	24			1680			14400	1500	12500	
Habitat 24-S	78	9000		1260		18000	10800	3000	32500	
Habitat 25-N	92	3600	32540			7200				
Habitat 26-S	24	3600				7200		1500	82500	
Habitat 27-N	58	5250		1610		10500			30000	
SUB-TOTALS	294	21450	38400	4970		42900	43200	9000	242500	

COST ESTIMATE
WILDLIFE HABITAT DEVELOPMENT
LOWER SNAKE RIVER PROJECT

Price Level
September 1974

Reservoir	Total Planting Acres	Planting @ $150 Per acre	Planting @ $480 Per acre	Planting @ $ 70 Per acre	Planting @ $350 Per acre	Traveling Unit Irrigation @ $300 Per acre	Solid Set Irrigation @ $600 Per acre	Power Line @ $1.50 Per foot	Fencing @$2.50 Per foot	Misc. costs
Lower Granite										
Habitat 31-S									120000	
SUB-TOTAL									120000	
Special Costs										
Palouse Area Fence (and other fencing outside intensive habitat areas)									329000	
One Windmill										4000
25 Corridor Fences (cattle access easement areas)									62500	
Habitat 23 Log Boom										13500
Farm Machinery										75000
Land Acquisition at Riparia - 100 acres										70000
Goose Nesting Structures (17 @ $2500)										42500
Easement negotiations										negligible
Nursery with Greenhouse							5000	900	2250	15000
SUB-TOTALS							5000	900	393750	220000
TOTALS	1094	85350	86400	10850	62300	198300	158600	21900	1101250	220000

TOTALS OF TOTALS	$1,944,950.00
15% Contingency	291,742.00
GRAND TOTAL	$2,236,692.00

Annual Operation and Maintenance Costs $120,000

Proposed Monitoring Contract with Washington Department of Game ($10,000 per year for 5 years).....$50,000

Development Cost - Estimate by Project

Ice Harbor		
Habitat Areas	$307,390	
Windmill	4,000	
Corridor Fences	18,000	
Fences Outside Habitats	27,500	
Goose Nest Structures	22,500	
Farm Machinery	20,000	
subtotal	$399,390	
15% contingency	59,908	
		$459,298
Lower Monumental		
Habitat Areas	$495,490	
Corridor Fences	22,000	
Fences Outside Habitats (including Palouse Canyon)	114,000	
Goose Nest Structures	10,000	
Farm Machinery	15,000	
subtotal	$656,490	
Riparia Lands	70,000	
subtotal	$726,490	
15% contingency	108,974	
		$835,464
Little Goose		
Habitat Areas	$402,420	
Corridor Fences	22,500	
Fences Outside Habitats	160,000	
Log Boom	13,500	
Goose Nest Structures	10,000	
Farm Machinery	20,000	
subtotal	$628,420	
15% contingency	94,263	
		$722,683
Lower Granite		
Habitat Area	$120,000	
Fences Outside Habitat	27,500	
Vegetation Nursery	23,150	
Farm Machinery	20,000	
subtotal	$190,650	
15% contingency	28,597	
		$219,247
GRAND TOTAL		$2,236,692

Lower Snake River Projects

Wildlife Mitigation Costs

Estimates

WASHINGTON
OREGON
IDAHO
NEVADA
SEATTLE
TACOMA
SPOKANE
PORTLAND
Bellingham
Everett
Olympia
Aberdeen
Wenatchee
Moses Lake
Yakima
Kellogg
Missoula
Lewiston
Walla Walla
Pendleton
The Dalles
La Grande
Baker
Salmon
Burns
Vale
Ontario
Idaho Falls
Pocatello
Twin Falls
Burley
Rexburg
Grants Pass
Medford
Coos Bay
Newport
Astoria
Longview
Vancouver
Centralia
Ellensburg
Sunnyside
Bend
Redmond
Prineville
Klamath Falls
Lakeview
Winnemucca
WYO
N
20 0 20 40 60 80 100
MILES

Table Habitat Improvement Needs for Wildlife - Identified by Non-Federal Agencies, Subregion 1 1/

Action		Unit	1980 Amount	1980 Cost ($1,000)	2000 Amount	2000 Cost ($1,000)	2020 Amount	2020 Cost ($1,000)
Habitat improvement 2/	1,000	acres	65	1,006	98	1,515	134	2,019
Land acquisition 3/	1,000	acres	15	2,622	11	1,689	24	3,758
Fencing 4/		miles	7	8	11	12	23	22
Water developments 5/		each	63	4	40	3	84	5
Supplemental feeding 6/		tons	205	15	174	19	336	30
Farm-reared game birds 7/		thousands	10	109	12	128	18	193
Total								

1/ Measures listed are not planned projects but represent actions needing funds additional to ongoing budgets.

2/ Includes cover plots, food patches, fencing, marsh development, potholes, nest structures, etc., not identified specifically in the table on game department controlled lands.

3/ Obtained by fee purchase and easement rights.

4/ Fencing represents damage control structures erected by agreement with land holders to eliminate depredations by deer and elk on private land.

5/ Water developments consist primarily of guzzler installations and spring development (including fencing) by agreement on private land (can include nest structures in other SR)

6/ Management tool designed to increase winter capacities for wildlife where restricted on public and private lands.

7/ Utilized to meet growing demand for upland bird hunting on decreasing land base.

Table Habitat Improvement Needs for Wildlife - Identified by Non-Federal Agencies, Subregion 2 1/

Action		Unit	1980 Amount	1980 Cost ($1,000)	2000 Amount	2000 Cost ($1,000)	2020 Amount	2020 Cost ($1,000)
Habitat improvement 2/	1,000	acres	650	313	774	463	962	689
Land acquisition 3/	1,000	acres	260	15,541	124	7,355	188	11,183
Fencing 4/		miles	345	119	38	57	57	86
Water developments 5/		each	360	22	177	11	258	16
Supplemental feeding 6/		tons	452	33	456	33	429	31
Farm-reared game birds 7/		thousands	62	827	30	394	45	598
Total								

1/ Measures listed are not planned projects but represent actions needing funds additional to ongoing budgets.

2/ Includes cover plots, food patches, fencing, marsh development, potholes, nest structures, etc., not identified specifically in the table on game department controlled lands.

3/ Obtained by fee purchase and easement rights.

4/ Fencing represents damage control structures erected by agreement with land holders to eliminate depredations by deer and elk on private land.

5/ Water developments consist primarily of guzzler installations and spring development (including fencing) by agreement on private land (can include nest structures in other SR)

6/ Management tool designed to increase winter capacities for wildlife where restricted on public and private lands.

7/ Utilized to meet growing demand for upland bird hunting on decreasing land base.

Table Habitat Improvement Needs for Wildlife - Identified by Non-Federal Agencies, Subregion 3 1/

Action		Unit	1980 Amount	1980 Cost ($1,000)	2000 Amount	2000 Cost ($1,000)	2020 Amount	2020 Cost ($1,000)
Habitat improvement 2/	1,000	acres	334	352	416	520	578	775
Land acquisition 3/	1,000	acres	247	9,962	82	3,291	162	6,460
Fencing 4/		miles	35	12	12	18	18	27
Water developments 5/		each	100	7	47	3	74	5
Supplemental feeding 6/		tons	2,015	148	1,853	135	1,900	139
Farm-reared game birds 7/		thousands	66	879	31	418	48	636
Total								

1/ Measures listed are not planned projects but represent actions needing funds additional to ongoing budgets.
2/ Includes cover plots, food patches, fencing, marsh development, potholes, nest structures, etc., not identified specifically in the table on game department controlled lands.
3/ Obtained by fee purchase and easement rights.
4/ Fencing represents damage control structures erected by agreement with land holders to eliminate depredations by deer and elk on private land.
5/ Water developments consist primarily of guzzler installations and spring development (including fencing) by agreement on private land (can include nest structures in other SR)
6/ Management tool designed to increase winter capacities for wildlife where restricted on public and private lands.
7/ Utilized to meet growing demand for upland bird hunting on decreasing land base.

Table Habitat Improvement Needs for Wildlife - Identified by Non-Federal Agencies, Subregion 7 1/

Action		Unit	1980 Amount	1980 Cost ($1,000)	2000 Amount	2000 Cost ($1,000)	2020 Amount	2020 Cost ($1,000)
Habitat improvement 2/	1,000	acres	133	144	199	212	299	317
Land acquisition 3/	1,000	acres	139	2,612	66	1,243	100	1,890
Fencing 4/		miles	54	16	5	8	3	5
Water developments 5/		each	88	5	43	3	64	4
Supplemental feeding 6/		tons	69	4	101	6	84	5
Farm-reared game birds 7/		thousands	22	288	11	137	16	209
Total								

1/ Measures listed are not planned projects but represent actions needing funds additional to ongoing budgets.
2/ Includes cover plots, food patches, fencing, marsh development, potholes, nest structures, etc., not identified specifically in the table on game department controlled lands.
3/ Obtained by fee purchase and easement rights.
4/ Fencing represents damage control structures erected by agreement with land holders to eliminate depredations by deer and elk on private land.
5/ Water developments consist primarily of guzzler installations and spring development (including fencing) by agreement on private land (can include nest structures in other SR)
6/ Management tool designed to increase winter capacities for wildlife where restricted on public and private lands.
7/ Utilized to meet growing demand for upland bird hunting on decreasing land base.

Table Habitat Improvement Needs for 1/
Wildlife - Identified by Non-Federal Agencies, Subregion 8

Action		Unit	1980 Amount	1980 Cost ($1,000)	2000 Amount	2000 Cost ($1,000)	2020 Amount	2020 Cost ($1,000)
Habitat improvement 2/	1,000	acres	30	2	44	3	50	3
Land acquisition 3/	1,000	acres	30	11,144	14	5,305	21	8,062
Fencing 4/		miles	32	11	4	5	5	8
Water developments 5/		each	0	0	0	0	0	0
Supplemental feeding 6/		tons	69	5	64	5	65	5
Farm-reared game birds 7/		thousands	12	166	6	79	9	120
Total								

1/ Measures listed are not planned projects but represent actions needing funds additional to ongoing budgets.
2/ Includes cover plots, food patches, fencing, marsh development, potholes, nest structures, etc., not identified specifically in the table on game department controlled lands.
3/ Obtained by fee purchase and easement rights.
4/ Fencing represents damage control structures erected by agreement with land holders to eliminate depredations by deer and elk on private land.
5/ Water developments consist primarily of guzzler installations and spring development (including fencing) by agreement on private land (can include nest structures in other SR)
6/ Management tool designed to increase winter capacities for wildlife where restricted on public and private lands.
7/ Utilized to meet growing demand for upland bird hunting on decreasing land base.

Table Habitat Improvement Needs for Wildlife - Identified by Non-Federal Agencies, Subregion 10 N 1/

Action		Unit	1980 Amount	1980 Cost ($1,000)	2000 Amount	2000 Cost ($1,000)	2020 Amount	2020 Cost ($1,000)
Habitat improvement 2/	1,000	acres	30	4	43	5	62	8
Land acquisition 3/	1,000	acres	27	10,635	13	5,062	20	7,698
Fencing 4/		miles	40	14	4	7	7	10
Water developments 5/		each	0	0	0	0	0	0
Supplemental feeding 6/		tons	37	3	35	3	35	3
Farm-reared game birds 7/		thousands	19	158	6	75	9	114
Total								

1/ Measures listed are not planned projects but represent actions needing funds additional to ongoing budgets.

2/ Includes cover plots, food patches, fencing, marsh development, potholes, nest structures, etc., not identified specifically in the table on game department controlled lands.

3/ Obtained by fee purchase and easement rights.

4/ Fencing represents damage control structures erected by agreement with land holders to eliminate depredations by deer and elk on private land.

5/ Water developments consist primarily of guzzler installations and spring development (including fencing) by agreement on private land (can include nest structures in other SR)

6/ Management tool designed to increase winter capacities for wildlife where restricted on public and private lands.

7/ Utilized to meet growing demand for upland bird hunting on decreasing land base.

TABLE 1-W PROPOSED NON-FEDERAL PROJECTS AND PROGRAMS REQUIRED TO FULFILL FUTURE NEEDS OF (~~XXXX~~) (WILDLIFE), SUBREGION 1

CATEGORY Items	AMOUNT REQUIRED By 1980 1/	PROJECTED EXPENDITURES 2/ ($1000's) TO YEA 1980	2000	2020
Habitat and Access Imp. 3/				
Big Game Habitat:				
Purchase (Fee)	5,440 acres	$ 979.0	$1,445.0	$2,153.0
Easement Rights	--			
Waterfowl Habitat:				
Purchase (Fee)	1,440 acres	778.0	1,148.0	1,711.0
Easement Rights	--			
Small Game Habitat:				
Purchase (Fee)	1,200 acres	216.0	319.0	475.0
Easement Rights	7,300 acres	326.0	481.0	717.0
Research and Management 4/				
Survey & Analysis(ongoing)	2,232,800 acres	23.1	32.5	48.6
Specific Research	Unknown	41.7	61.5	91.7
Habitat/Access Mgmt.	15,380 acres	6.0	8.8	13.1
Facility Management	4,479 birds	8.1	11.9	18.7
Artificial Augmentation 5/				
Bird Farms	4,479 birds	59.2	87.3	130.2
Supplemental feeding	155.4 tons	11.4	21.9	32.6
Mechanical Devices 6/				
Water Developments	53 sites	2.7	4.0	5.9
Wildlife fencing	2.2 miles	3.3	4.8	7.2
GRAND TOTAL		$2,454.5	$3,625.7	$5,404.0

TABLE 2-W PROPOSED NON-FEDERAL PROJECTS AND PROGRAMS REQUIRED TO FULFILL FUTURE NEEDS OF (XXXX) (WILDLIFE), SUBREGION 2

CATEGORY Items	AMOUNT REQUIRED By 1980 1/	PROJECTED EXPENDITURES 2/ ($1,000's) TO YEAR 1980	2000	2020
Habitat and Access Imp. 3/				
Big Game Habitat:				
Purchase (Fee)	284,972 acres	$1,401.0	$2,068.0	$3,081.0
Easement Rights	--			
Waterfowl Habitat:				
Purchase (Fee)	178,546 acres	1,983.0	2,297.0	4,362.0
Easement Rights	106,784 acres	1,442.0	2,128.0	3,172.0
Small Game Habitat:				
Purchase (Fee)	19,999 acres	4,585.0	6,767.0	7,682.0
Easement Rights	60,042 acres	6,004.0	8,862.0	13,207.0
Research and Management 4/				
Survey & Analysis (ongoing)	14,080,000 acres	195.5	288.7	430.2
Specific Research	Unknown	259.9	383.6	571.7
Habitat/Access Mgmt.	650,343 acres	313.6	462.9	689.8
Facility Management	62,208 birds	116.4	171.8	256.0
Artificial Augmentation 5/				
Bird Farms	62,208 birds	827.1	1,220.8	1,819.3
Supplemental feeding	451.7 tons	33.1	63.4	94.6
Mechanical Devices 6/				
Water developments	360 sites	22.4	33.1	49.3
Wildlife fencing	345 miles	118.9	175.5	261.5
GRAND TOTAL		$17,301.9	$24,921.8	$35,676.4

TABLE 3-W PROPOSED NON-FEDERAL PROJECTS AND PROGRAMS REQUIRED TO FULFILL FUTURE NEEDS OF ([redacted]) (WILDLIFE), SUBREGION 3

CATEGORY Items	ANNUAL OUTPUT By 1980 1/	PROJECTED EXPENDITURES 2/ ($1000's) TO YEAR 1980	2000	2020
Habitat and Access Imp. 3/				
Big Game Habitat:				
Purchase (Fee)	320,205 acres	$2,500.0	$3,715.0	$5,499.0
Easement Rights	--			
Waterfowl Habitat:				
Purchase (Fee)	8,949 acres	3,947.0	5,826.0	8,682.0
Easement Rights	2,600 acres	520.0	768.0	1,144.0
Small Game Habitat:				
Purchase (Fee)	611 acres	120.0	177.0	264.0
Easement Rights	1,500 acres	1,875.0	2,767.0	4,124.0
Research and Management 4/				
Survey & Analysis(ongoing)	3,851,400 acres	96.3	142.2	211.9
Specific Research	Unknown	70.9	104.6	155.9
Habitat/Access Mgmt.	333,865 acres	352.2	520.0	775.0
Facility Management	66,033 birds	123.6	182.4	271.9
Artificial Augmentation 5/				
Bird Farms	66,033 birds	878.6	1,296.8	1,932.6
Supplemental feeding	2014.5 tons	147.6	282.9	421.6
Mechanical Devices 6/				
Water Developments	100 sites	6.8	10.0	15.0
Wildlife fencing	35.4 miles	12.1	17.9	26.6
GRAND TOTAL		$10,650.1	$15,809.8	$23,523.5

TABLE 6-W PROPOSED NON-FEDERAL PROJECTS AND PROGRAMS REQUIRED TO FULFILL FUTURE NEEDS OF (~~XXXX~~) (WILDLIFE), SUBREGION 6

CATEGORY Items	AMOUNT REQUIRED By 1980 1/	PROJECTED EXPENDITURES 2/ ($1000's) TO Y 1990	2000	2020
Habitat and Access Imp. 3/				
Big Game Habitat:				
Purchase (fee)	64,733 acres	$ 674.0	$ 994.0	$1,482.0
Easement rights	800 acres	36.0	53.0	79.0
Waterfowl Habitat:				
Purchase (fee)	10,900 acres	2,725.0	4,022.0	5,994.0
Easement rights	46,840 acres	1,171.0	1,728.0	2,575.0
Small Game Habitat:				
Purchase (fee)	2,321 acres	592.0	873.0	1,292.0
Easement rights	5,808 acres	581.0	858.0	1,276.0
Research and Management 4/				
Survey & Analysis(ongoing)	3,508,700 acres	63.8	95.5	142.2
Specific Research	Unknown	64.6	95.3	142.1
Habitat/Access Mgmt.	131,402 acres	72.0	106.3	158.5
Facility Management	29, 962 birds	56.1	82.8	123.4
Artificial Augmentation 5/				
Bird Farms	29,962 birds	398.7	588.4	877.0
Supplemental feeding	37.4 tons	2.8	5.4	8.0
Mechanical Devices 6/				
Water Developments	92 sites	5.9	8.7	13.0
Wildlife fencing	19.1 miles	6.6	9.7	14.5
GRAND TOTAL		$6,449.5	$9,520.1	$14,178.7

TABLE 7-W PROPOSED NON-FEDERAL PROJECTS AND PROGRAMS REQUIRED TO FULFILL FUTURE NEEDS OF (XXXX) (WILDLIFE), SUBREGION 7

SUMMARY Items	ADDITIONAL NEEDED By 1980 1/	PROJECTED EXPENDITURES 2/ (1000's) TO BE MADE		
		1980	2000	2020
Habitat and Access Imp. 3/				
Big Game Habitat:				
Purchase (fee)	110,823 acres	$1,795.0	$2,649.0	$3,948.0
Easement rights	20,000 acres	90.0	133.0	198.0
Waterfowl Habitat:				
Purchase (fee)	8,780 acres	(Present total - no new purchase anticip		
Easement rights	11,000 acres	11.0	16.0	24.0
Small Game Habitat:				
Purchase (fee)	2,169 acres	716.0	1,057.0	1,575.0
Easement rights	--			
Research and Management 4/				
Survey & Analysis(ongoing)	3,455,600 acres	30.6	45.0	67.1
Specific Research	Unknown	63.8	94.2	140.3
Habitat/Access Mgmt.	132,500 acres	143.9	212.3	316.5
Facility Management	21,659 birds	40.5	59.8	89.1
Artificial Augmentation 5/				
Bird Farms	21,659 birds	288.0	425.0	633.5
Supplemental feeding	69.1 tons	3.9	9.6	14.3
Mechanical Devices 6/				
Water Developments	88 sites	5.4	8.0	11.9
Wildlife Fencing	53.6 miles	15.9	23.5	28.6
GRAND TOTAL		$3,204.0	$4,732.4	$7,046.3

TABLE 8-W PROPOSED NON-FEDERAL PROJECTS AND PROGRAMS REQUIRED TO FULFILL FUTURE NEEDS OF (~~Xxxx~~) (WILDLIFE), SUBREGION 8

CATEGORY Items	AMOUNT REQUIRED By 1980 1/	PROJECTED EXPENDITURES 2/ ($1000's) TO YEA 1980	2000	2020
Habitat and Access Imp. 3/				
Big Game Habitat:				
Purchase (fee)	1,120 acres	$ 448.0	$ 661.0	$ 985.0
Easement rights	600 acres	60.0	88.0	130.0
Waterfowl Habitat:				
Purchase (fee)	17,699 acres	8,771.0	12,946.0	19,294.0
Easement rights	2,000 acres	270.0	399.0	594.0
Small Game Habitat:				
Purchase (fee)	2,514 acres	995.0	1,469.0	2,188.0
Easement rights	6,000 acres	600.0	886.0	1,320.0
Research and Management 4/				
Survey & Analysis(ongoing)	3,030,000 acres	47.8	70.5	105.1
Specific Research	Unknown	55.9	82.5	118.9
Habitat/Access Mgmt.	29,933 acres	1.9	2.8	3.2
Facility Management	12,453 birds	23.4	34.5	51.4
Artificial Augmentation 5/				
Bird Farms	12,453 birds	166.0	245.0	365.1
Supplemental feeding	69.1 tons	5.0	9.6	14.3
Mechanical Devices 6/				
Water Developments	None			
Wildlife fencing	32.2 miles	11.1	16.4	24.4
GRAND TOTAL		$11,455.1	$16,511.3	$25,193.3

TABLE 10-W PROPOSED NON-FEDERAL PROJECTS AND PROGRAMS REQUIRED TO FULFILL FUTURE NEEDS OF (~~Xxxx~~) (WILDLIFE), SUBREGION 10 North

Items	Added Required by 1980 1/	Projected Expenditures 2/ ($1,000's) to the Year 1980	2000	2020
Habitat and Access Imp. 3/				
Big Game Habitat:				
Purchase (fee)	3,282 acres	928.0	$1,370.0	$2,041.6
Easement rights	--			
Waterfowl Habitat:				
Purchase (fee)	17,079 acres	8,110.0	11,970.0	17,840.0
Easement rights	240 acres	32.0	47.0	70.0
Small Game Habitat:				
Purchase (fee)	1,950 acres	829.0	1,224.0	1,824.0
Easement rights	7,360 acres	736.0	1,086.0	1,619.0
Research and Management 4/				
Survey & Analysis(ongoing)	4,069,700 acres	57.8	85.3	127.1
Specific Research	Unknown	74.8	110.4	164.5
Habitat/Access Mgmt.	29,911 acres	3.6	5.4	8.0
Facility Mgmt.	19,402 birds	36.3	53.4	79.8
Artificial Augmentation 5/				
Bird Farms	19,402 birds	158.4	233.8	348.4
Supplemental feeding	37.4 tons	2.8	5.4	8.0
Mechanical Devices 6/				
Water developments	None			
Wildlife fencing	39.5 miles	13.6	20.1	29.9
GRAND TOTAL		$10,982.3	$16,210.8	$24,159.7

TABLE 11-W PROPOSED NON-FEDERAL PROJECTS AND PROGRAMS REQUIRED TO FULFILL FUTURE NEEDS OF (~~XXXX~~) (WILDLIFE), SUBREGION 11

ACTIVITY Items	AMOUNT REQUIRED By 1970 1/	PROJECTED EXPENDITURES 2/ ($1000's) TO YEAR 1980	2000	2020
Habitat and Access Imp. 3/				
Big Game Habitat:				
Purchase (fee)	5,000 acres	$ 200.0	$ 295.0	$ 440.0
Easement rights	15,000 acres	1,500.0	2,214.0	3,300.0
Waterfowl Habitat:				
Purchase (fee)	42,690 acres	14,960.0	22,080.0	32,907.0
Easement rights	14,115 acres	1,900.0	2,804.0	4,179.0
Small Game Habitat:				
Purchase (fee)	3,942 acres	1,213.0	1,790.0	2,668.0
Easement rights	4,760 acres	476.0	703.0	1,009.0
Research and Management 4/				
Survey & Analysis(ongoing)	8,446,600 acres	147.9	218.3	325.3
Specific Research	Unknown	136.0	230.2	343.1
Habitat/Access Mgmt.	85,507 acres	21.9	32.4	48.3
Facility Mgmt.	61,376 birds	114.9	169.6	252.7
Artificial Augmentation 5/				
Bird Farms	61,376 birds	816.0	1,204.4	1,794.9
Supplemental feeding	43.1 tons	3.2	6.1	9.1
Mechanical Devices 6/				
Water Developments	None			
Wildlife fencing	89.1 miles	30.6	45.2	67.3
GRAND TOTAL		$21,539.5	$31,792.2	$47,343.7

1/ Accumulative amount required by 1980 including past, ongoing, and anticipated programs.

2/ Expenditures indicate capitol cost estimates from present to target year. Research and management expenditures represent anticipated annual costs at target year only. All figures are based on present dollar values expanded by predicted population growth rates.

3/ Habitat and access improvement is represented primarily by lands acquired and developed. Two methods of acquisition are anticipated - outright purchase, and by easement. The latter is intended to assure perpetual access and limited management rights on private land. Figures are based on subregional inventory of projected needs.

4/ Indicates annual expenditures for ongoing management, analysis and various research to improve quality and quantity of wildlife-oriented recreation. Figures are based on anticipated needs to meet future demand.

5/ Indicates capitol costsof bird farms and supplemental feeding based on present, ongoing programs expanded to meet anticipated demand.

6/ Indicates capitol costs for water developments, (springs and guzzlers) and wildlife fencing based on present, ongoing programs expanded to meet anticipated demand.

Wetland Economics

BENSON, Dirck and Robert F. Perry. "An Acre of Marsh is Worth ---." The New York State Conservationist 19(6):30-33, 1965.

A variety of values attached to marshland were aggregated to show the capitalized value of an acre of marsh in New York in 1965 to be $350 to $400. Some of the value components were: water values of $0.19; product values of $0.10; habitat values of about $11.48 (including a value for duck habitat ranging from $1.10 to $10); recreational values of $6.05; and $0.75 annual net value of education returns. These values were estimated using various types of data that included expenditures and sales of bait. Duck values were estimated to be $5 per duck times a coefficient of 0.22 ducks per acre per year.

GOOSELINK, J.G., E.P. Odum, and R.M. Pope. The Value of the Tidal Marsh. Baton Rouge: Louisiana State University Center for Wetlands Resources Report No. LSU-SG-74-03, 30 pages, 1974.

Values of natural tidal marshes at four levels are estimated. They include: (1) by-product production (fisheries, etc.); (2) potential for aquacultural development; (3) waste assimilation; and (4) total life support value of natural functions in primary production.

HARMON, Keith W. "The Economics of Wetland Values." Watertown, South Dakota: U.S. Fish and Wildlife Service Wetland Symposium, June 8-9, 11 pages (mimeo), 1976.

The need for economic evaluation of wetlands in stressed in this paper. Several examples of wetland values that are higher than alternative uses which involve destruction of wetlands are presented. One method discussed by the author for determining dollar values is to calculate cash outlays required to procide a service--pollution control for instance-were it not provided by the wetland.

"Raising Manmade Marshlands." Water Spectrum 8(2):35-37, Fall 1976.

A reprint of two accounts of manmade marshlands. "Slaughter Creek Solution" by Dick Whitaker, provides an example of marshland creation in Maryland. "Engineers Build Marsh on Mississippi," by Roy Reed, discusses the possibility of creating new coastal marshes along the Mississippi River in southern Louisiana.

SORENSON, Lee A. Alternative Uses of Wetlands. Fargo: North Dakota State University, M.S. thesis, 115 pages, March 1975.

The importance of wetlands to hunting activity in North Dakota and the impact of expenditures by hunters on the North Dakota economy are addressed in this study. A questionnaire was used to collect data on expenditures by

hunters, and farm operators were surveyed to determine their attitudes toward wetlands. Using an input-output model, it was estimated that the gross business volume generated in North Dakota by resident hunter expenditures was $54.3 million in 1973. The average annual expenditures for waterfowl, small game, and big game hunters were $181.45, $89.49, and $159.34, respectively. The average number of days spent hunting waterfowl, small game, and big game was 7.6, 8.5, 6.1, respectively. About 55 percent of the gross business volume generated by hunters was attributed to the existence of wetlands.

WHITESELL, Dale E. "Providing Habitat for Migratory Birds Through Private Efforts." Transactions of the Forty-First North American Wildlife and Natural Resources Conference 41:513-516, 1976.

A discussion of maintaining wetlands under private ownership. Incentive is the key ingredient to retain private wetlands. Some incentives were suggested, such as a lower tax bill, fish as a cash crop, and drought and flood protection.

Economics of Fish and Wildlife and Their Habitats

Refer to citation and annotation - SORENSON, Lee A.

ARMSTRONG, W.W. The Economic Value of Hunting and Fishing in Arizona in 1956. Phoenix: Arizona Game and Fish Department Wildlife Bulletin No. 4, 1958.

BELL, Thomas A. A Study of the Economic Values of Wyoming's Wildlife Resources. Laramie: University of Wyoming, M.S. thesis, 140 pages, 1957.

A study comparing gross expenditures of recreationists in Wyoming with gross business volumes generated in agricultural sectors in the state of Wyoming. An 80 percent return rate of 3,263 mail questionnaires to both resident and nonresident hunters and fishermen and resident trappers was achieved.

BINNS, Niles Allen. An Inventory and Evaluation of the Game and Fish Resources of the Upper Green River in Relation to Current and Proposed Water Development Programs. Laramie: University of Wyoming Water Resource Research Institute, 212 pages, November 1972.

From 1967 to 1970, an inventory was made of wildlife resources of the Upper Green River in Wyoming with the objectives of evaluating the general quality of the wildlife resources and of predicting the effects of water development programs on these resources in the future. The results of a postcard survey indicated that the esitmated total value of the fishery was $548,370 or $12,180 per river mile.

BRAUN, Clait E. A Survey of Land Values Directly Attributable to Waterfowl Within the Contiguous United States. Missoula: Montana State University, M.S. thesis, 1965.

This thesis reports on the results of a quesionnaire which 247 duck and waterfowl clubs responded to. Information was also obtained from individuals

in the fields of game and fish management and land assessment. Land values attributed to waterfowl were related to type of fowl, hunting potential, dependability of flights, nearness to population centers, cropland versus wetland, hunting regulations, potential harvest per acre, availability of free public lands, and alternative land uses. Mean annual value per acre attributable to waterfowl for the period 1959-1963 ranged from $3.60 for ducks in the central flyway to $60.72 for geese in the Mississippi flyway. The value of good farmland with the potential for goose for duck hunting was much higher than the value of good farmland alone. Information on waterfowl clubs in the four flyways is also provided.

BROWN, William G., Farid H. Nawas, and Joe B. Stevens. The Oregon Big Game Resource: An Economic Evaluation. Corvallis: Oregon State University Agricultural Experiment Station Special Report No. 379, ii + 110 pages, March 1973.

A review and evaluation of various proposed methods for estimating net economic benefits of publicly owned recreational resources. Gross economic values of the big game resource were estimated using the impact of hunter expenditures on business sales as well as the effect on household income. Linear and exponential demand functions were estimated and estimates of net economic values to a nondiscriminating monopolist and consumer surplus were calculated. Nondiscriminating monopolist values were $5 million while consumer surplus values were $12 million based on the linear function. Using the exponential demand funcion nondiscriminating monopolist values were $3.7 million and the consumer surplus value was $10 million for big game in Oregon in 1968.

BROWN, William G., Ajmer Singh, and Emergy N. Castle. "Net Economic Value of Oregon Salmon-Steelhead Sport Fishery." Journal of Wildlife Management 29:266-279, April 1965.

Demand functions for a sport fishery were estimated using data on income and disease traveled by anglers. Net economic value was estimated to be about $3 million in 1962. The net economic value, which was measured from the demand function, is the annual value of the sport fishery resource to a single owner if a market existed for the opportunity to fish for salmon and steelhead.

BROWNLEE, W.C. Kerr Wildlife Management Area Research, Job No. 13: Economics of Deer and Livestock Production.

A continuation of work in Texas previously reported by C.W. Ramsey. Potential rancher profits per acre from deer during the study period were $11.23, as compared to $52.55 for cattle and $30.59 for sheep. The return for deer in the previous year was estimated to be $81.64.

ELLEFSON, Paul V. and Gale C. Jamsen. Economic Appraisal of Michigan's Salmon and Steelhead Sport Fishery, September 1 - December 31, 1970. Lansing: Michigan Department of Natural Resources Research and Development Report No. 244, 12 pages, June 1970.

An impirical example of Clawson's travel zone method is presented for the salmon and steelhead sport fishery in Michigan. Some findings were that

fishermen spend an average of $9.76 each day they fish. This varied from a low of $8.19 per day for Lake Superior fishermen to a high of $10.01 for Lake Michigan fishermen. Very few fishermen reported spending more than $25 per day. The net economic value of this fishery for the last four months of 1970 was estimated to be $4.2 million, with a capitalized value of $77.1 million (5.5%). The net value of an angler day during this time period was estimated to be $4.86. This represents the dollar value of the recreation that would be lost had a fisherman been denied an opportunity to fish one day for salmon and steelhead although allowed to partake of other recreation activities for one day. The authors caution readers on the use of these figures in decision making since they feel that they are conservative estimates.

ERICKSON, R.E. and J.E. Wiebe. "Pheasants, Economics, and Land Retirement Programs in Sough Dakota." Wildlife Society Bulletin 1(1):22-27, Spring 1973.

Numbers of nonresident hunters in South Dakota were correlated significantly with pheasant populations, which in turn were correlated significantly with acres of cropland retired in vegetation cover. The authors argued that an increase in nonresident hunter expenditures of at least $10 million could be realized if one half of South Dakota's current (1971) 3.4 million acres of retired cropland contained suitable vegetative cover.

FORESTER, Richard T. "Landowner Utilization of a Wild Pheasant Resource." California Fish and Game 57(4):298-306, 1971.

Seven percent of the landowners in Stanislaus County, California, leased their lands to pheasant hunters, while most landowners gave permission to hunt without charging a fee. Leasees' land averaged over $600 income per year. Pheasant hunting on leased land resulted in a much higher success ratio.

HAINES, Bruce. Cost-Benefit Ratio of Alburquerque-Belen Catchable Trout Fishery. Santa Fe: New Mexico Department of Game and Fish Project No. F-22-$-12, 12 pages, January 7, 1972.

A survey of Bernalillo County combination fishing and hunting and fishing license holders indicated 5,500 licensed anglers participate annually in the Alburquerque-Belen winter trout fishery. Over the two-year span of the study, 460,000 hours of recreation were generated by the fishery. The two-year cost of the fishery, based on $0.925 per pound of fish planted, was $20,000. The cost-benefit ratio was $0.04 per angler hour. Other fisheries in the state had per hour cost-benefit ratios of from $0.07 to $0.32.

HALLS, Lowell K. "Economic Feasibility of Including Game Habitats in Timber Management Systems." Transactions of the Fortieth North American Wildlife and Natural Resources Conference 40:168-174, 1975.

The trend in forest management in the southern part of the U.S. is to include game and to charge a fee for hunting. In 1972, Gulf State Paper Company charged the following fees for hunting on property the firm owned in Alabama: $1 to $3 per acre on upland sites; $2.50 to $6 per acre on bottomland hardwoods; and $10 to $20 per acre on especially good sites with special services. The practice was profitable enough for the firm to adjust its timber management to accommodate game.

HAMMACK, Judd and Gardner Mallard Brown, Jr. Waterfowl and Wetlands: Toward Bioeconomic Analysis. Washington, D.C.: Resources for the Future, Inc., 95 pages, 1974.

The marginal value of a duck was estimated using data obtained from a nationwide survey of hunters in 1968. This value was estimated to be $3.29 per duck for 1968. Both willingness to pay and willingness to sell were discussed. The supply function of waterfowl was also investigated.

HAMOR, W.H. "Costs and Returns of Producing Wildlife on Farmland." Journal Soil Water Conservation 23(1):16-18, January - February 1968.

A method is suggested wherby a landowner can manage a portion of his land for waterfowl, lease it to hunters, and receive at least as much income as if he had farmed the area.

HORVATH, Joseph C. "Economic Survey of Southeastern Wildlife and Wildlife-Oriented Recreation." Transactions of the Thirty-Ninth North American Wildlife and Natural Resources Conference 39:187-194, 1974.

A household survey of a sample of residents in seven southeastern states was conducted in 1971 to obtain data on none types of wildlife uses. Four value measurements were asked for: benefits received, benefits assigned, value demanded to give up, and days' pay lost. The average monetary benefit received for a day of fishing was $43; for hunting, $47; and for wildlife enjoyment, $71. Values to give up these activities were somewhat higher than the estimated value of benefits received.

LEITCH, J.A. and William C. Nelson. Economic Value of Wildlife in the Lower Sheyenne River Basin: Comparison of Four Measurement Techniques. Fargo: North Dakota State University Department of Agricultural Economics Report No. 114, 25 pages, July 1976.

The economic value of the wildlife community in the Lower Sheyenne River Basin (LSRB) in North Dakota is estimated and four techniques frequently used to estimate the economic value of wildlife are compared. An estimate of the personal communications with State Game and Fish Department personnel. To determine the value of wildlife, four techniques were applied to the LSRB; (1) utility value, (2) expenditures, (3) the value of comparative private recreation, and (4) wildlife land value.

NAWAS, Farid. The Oregon Big Game Resource: An Economic Evaluation. Corvallis: Oregon State University, Ph.D. dissertation, 166 pages, 1971. *33(1):45-A.

The gross economic value of the Oregon big game resource was estimated on the basis of information obtained from two questionnaires mailed to a random sample of Oregon big game hunters in 1968. Net economic value was defined as the potential value of the resource if the opportunity to hunt big game animals were a marketable commodity. Estimation of values was based on individual observations as compared to traditional distance zone estimation procedures. Using the concept of consumer surplus, an estimated net economic value of $11 million was calculated for the Oregon big game resource in 1968.

NORMAN, Richard L., Laren A. Roper, Perry D. Olson, and Robert L. Evans. Using Wildlife Values in Benefit-Cost Analysis and Mitigation of Wildlife Losses. Denver: Colorado Division of Wildlife Report No. DOW-M-D-3, 18 pages, 1976.

A method for estimating dollar values of wildlife and wildlife habitat is presented. The basic assumption is that the real value of wildlife losses is equal to the value of land required to totally replace the wildlife lost. Product data files are established for each wildlife resource including nongame species. The value of one bighorn sheep was estimated to be $11,200; and antelope $234; a black bear $6,400; a duck $20.79; a goose $168.72; and a skunk $2.02. An acre of pan fish water was estimated to be worth $520, while an acre of water habitat for three species of trout was valued at $10,000 each. A 6 percent capitalization rate was used to determine the value of a wildlife resource in perpetuity. If a wildlife resource could not be replaced in some other geographic area, the proposed project would be opposed. Wildlife value data from Ashton et al. (1974) and Horvath (1974) were used as the basis for estimating product values.

OLIVER, Wendell H. Economics as a Wildlife Management Tool. Proceedings of the Sixty-Seventh Convention, International Association of Fish and Wildlife Agencies. September 12-14, 1977, Vancouver, B.C., pages 82-92.

Describes the method used in Washington State to measure the economic value of wildlife-oriented recreation. The annual business produced by wildlife represents a major industry: about $466 million in 1975. The cash flow produced by this industry had a capitalized value of $7.77 billion. This sum represents the value of the wildlife resource. Four economic surveys in Washington State residents. Bioeconomic guidelines developed from these surveys are used to 1) represent wildlife in benefit/cost analyses, 2) participate in comprehensive planning, 3) describe wildlife's value in public forums, 4) make environmental impact assessments, and 5) negotiate wildlife mitigation. Identification of wildlife's monetary value adds an important dimension to habitat preservation efforts. If wildlife managers are to effectively preserve, protect, perpetuate and enhance wildlife resources, we must use economic criteria to evaluate wildlife habitat. Until we can fully comprehend habitat replacement technology and its costs, we must use recreation values as a basis for evaluating wildlife.

PAYNE, B.R. and R.M. Degraff. "Economic Values of Recreational Trends Associated with Human Enjoyment of Nongame Birds." Proceedings of the Symposium on Management of Forest and Range Habitats for Nongame Birds (May 6-9, 1975, Tucson, Arizona). Washington, D.C.: U.S. Forest Service General Technical Report WO-1, pp. 6-10, 1975.

PFEIFFER, Peter W. Monetary Values of Fish. The Pollution Committee, Southern Division, American Fisheries Society, 18 pages, 1975.

This is a revision of a 1970 publication compiled and prepared by recognized experts in the field of fishery biology. The revision reflects production cost increases over the five-year interval. The revised values were determined by a survey of commercial hatcheries in 1974 to determine the price of large-mouth bass, bluegill, channel catfish, carp, trout, and bait fishes. The values presented represent the average purchase price of each fish at the hatchery, and do not include transportation costs or expenses incurred in assessment and restocking procedures. A walleye over 15 inches was worth $4.56 per pound, a northern pike over 14 inches was worth $3.99 per pound, and a muskellunge over 14 inches was worth $11.40 per pound.

PRATO, Anthony A. "Economic Value of Wildlife." Proceedings of the Forty-Fifth Annual meeting of the Western Agricultural Economics Society, 8 pages (mimeo), 1975.

The author argues that the value of wildlife in wildlife recreation is less than the value of the total wildlife recreation experience, particularly for consumptive forms of wildlife recreation such as hunting and to a certain extent for nonconsumptive forms. If this relationship can be demonstrated, then valuation methods that equate the economic value of wildlife to the economic value of wildlife recreation are inappropriate. A utility production function model of recreation behavior is used to support this argument.

RAMSEY, C.W. "Potential Economic Returns from Deer as Compared with Livestock in the Edwards Plateau Region of Texas." Journal of Range Management 18:(5)247-249, 1965.

The net return per animal unit of deer harvested under optimum harvest conditions compares favorably with the return from livestock. 1955-1959 average gross return per deer harvested was $42. The best net return for deer was $38, while livestock in the best single year was $29. It is suggested that as hunting demand grew over the five-year period so did the economic value of the deer herd.

U.S. Fish and Wildlife Service, U.S. Department of Interior. 1970 National Survey of Fishing and Hunting. Washington, D.C.: Bureau of Sport Fisheries and Wildlife Resource Publication 95, 108 pages, 1972. (149.66:95).

Statistical data on socioeconomic characteristics of individuals participating in hunting and fishing activities in the United States. In 1970, hunters spent an average of $10.52 each recreation day and fishermen spent $7.02 each day. This survey has been conducted at five-year intervals since 1955.

What is Hunting Worth in New Jersey? Trenton: New Jersey Division of Fish and Game, 27 pages, 1970.

Results of a mail survey conducted in New Jersey to obtain data on hunter expenditures for determining the value of the state's wildlife resources are presented. Some values estimated were: deer, $736.50; rabbits, $15.18; squirrels, $15.28; pheasants, $19.85; and ducks, $44.53 each.